FINAL

SHORELINE ANALYSIS REPORT
Including Shoreline Inventory and Characterization for the City of Kirkland's Lake Washington Shoreline
Tasks 3, 4 and 5

Prepared for:

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City of Kirkland
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Including Shoreline Inventory and Characterization for the City of Kirkland's Lake Washington Shoreline

Project: Comprehensive Shoreline Master Program Update

- **Task 3: Inventory and Map Shoreline Conditions**
- **Task 4: Conduct Analysis**
- **Task 5: Prepare Final Analysis Report and Refined Maps**

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The views expressed herein are those of the authors and do not necessarily reflect the views of NOAA or any of its subagencies.

1 December 2006

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1.0 INTRODUCTION

1.1 BACKGROUND AND PURPOSE

The City of Kirkland (City) obtained a grant from the Washington Department of Ecology (Ecology) in 2005 to conduct a comprehensive Shoreline Master Program (SMP) update. The first steps of the update process are to inventory and characterize the City's shorelines as defined by the state's Shoreline Management Act (SMA) (RCW 90.58). The inventory and characterization were conducted according to direction provided in the Shoreline Master Program Guidelines and project Scope of Work promulgated by Ecology, and include areas within current City limits and the established Potential Annexation Area (PAA) north of the City. This shoreline inventory and characterization will describe existing conditions and assess ecological functions and ecosystem-wide processes operating in the shoreline jurisdiction. This analysis will serve as the baseline from which future development actions in the shoreline will be measured. The Guidelines require that the City demonstrate that its updated SMP yields "no net loss" in shoreline ecological functions relative to the baseline due to its implementation. Ideally, the SMP in combination with other City and regional efforts will ultimately produce a net improvement in shoreline ecological functions (see Section 3.11 for more discussion).

A list of potential information sources was compiled and an information request letter was distributed to potential interested parties and agencies that may have relevant information (Appendix A). Collected information was supplemented with other resources such as City documents, scientific literature, personal communications, aerial photographs, internet data, and a brief physical inventory of the City's shorelines.

1.2 SHORELINE JURISDICTION

As defined by the Shoreline Management Act of 1971, shorelines include certain waters of the state plus their associated "shorelands." At a minimum, the waterbodies designated as shorelines of the state are streams whose mean annual flow is 20 cubic feet per second (cfs) or greater or lakes whose area is greater than 20 acres. Shorelands are defined as:

> "those lands extending landward for 200 feet in all directions as measured on a horizontal plane from the ordinary high water mark; floodways and contiguous floodplain areas landward 200 feet from such floodways; and all wetlands and river deltas associated with the streams, lakes, and tidal waters which are subject to the provisions of this chapter…Any county or city may determine that portion of a one-hundred-year-floodplain to be included in its master program as long as such portion includes, as a minimum, the floodway and the adjacent land extending landward two hundred feet therefrom (RCW 90.58.030)"

The City's Shoreline Master Program was first adopted in the early 1970s and amended in the 1980s. Areas of the shoreline were designated as Conservancy Environment, Urban Mixed, Urban Residential and Suburban residential (Figures 1a[1] and 2). All of these designations,

[1] All figures are included in Appendix E at the end of this report.

except Suburban Residential, are further broken down into subcategories “1” and “2.” The largest designation on the original map is Suburban Residential, with smaller, roughly equal areas of Urban Residential and Urban Mixed. The two Conservancy areas are found at each end of the City. These include the large wetland associated with Forbes Creek and Juanita Bay at the north end of the City, and the large wetland associated with Yarrow Bay, Cochran Springs Creek and Yarrow Creek at the south end.

The City’s shoreline boundary has been updated (subject to City Council and Ecology approval) concurrent with this assessment (Figure 1b). Two changes were made, both in the Conservancy Environment areas, based on mapping of associated wetlands. The Yarrow Bay Wetlands mapping has been updated. A more significant correction was made to the wetland on Juanita Bay that extends up the Forbes Creek corridor. The previous map showed the wetland extending about 1,800 feet from the shore instead of approximately 1 mile. The rationale for the extension is explained further in Appendix B.

As part of the shoreline jurisdiction assessment, both Forbes Lake and Totem Lake were reviewed. Both lakes were found to be smaller than 20 acres, and thus not subject to regulation under the Shoreline Management Act. The analysis of these lakes can also be found in Appendix B.

1.3 STUDY AREA

The City of Kirkland is located in King County along a 5.75-mile portion of the eastern shoreline of Lake Washington. The City is bordered to the south by the City of Bellevue, to the southwest by the Town of Yarrow Point, and to the east by the City of Redmond. Unincorporated areas of King County lie to the north and in small pockets along the eastern boundary. Interstate-405 runs north to south near the center of the City. The City encompasses approximately 10.4 square miles. The City’s Potential Annexation Area (PAA), which continues north and west from Juanita Beach Park up to St. Edwards State Park, encompasses another 6.96 square miles of primarily single-family residential area.

The study area for this report includes all land currently within the City’s proposed shoreline jurisdiction, as well as shoreline in the PAA currently regulated under King County’s SMP (Figure 1b). The total area currently subject to the City’s SMP is approximately 233.7 acres (0.37 square miles), and encompasses 32,238 lineal feet (6.1 miles) of Lake Washington waterfront. The PAA shoreline area, although discussed in this report, will continue to be regulated by King County’s SMP until it is annexed by the City of Kirkland. That area is approximately 88.4 acres (0.14 square miles), and encompasses 20,491 lineal feet (3.9 miles) of Lake Washington waterfront.

2.0 CURRENT REGULATORY FRAMEWORK SUMMARY

2.1 CITY OF KIRKLAND

The Shoreline Management Act of 1971 brought about many changes for local jurisdictions around Lake Washington, including the City of Kirkland. With the goal “to prevent the inherent harm in an uncoordinated and piecemeal development of the state's shorelines," the City's Shoreline Master Program was developed to help regulate shoreline development in an ecologically sensitive manner with special attention given to public access. A history of the City's ordinances and resolutions pertaining to the Shoreline Master Program is presented in Appendix H. Many significant transformations to the City's shoreline have occurred since the first SMP was adopted. Among others, these have included:

- limiting overwater construction only to water dependent uses, thereby restricting any additional development of commercial and residential structures over the water;
- development of public access trails along most of the City's urban shoreline;
- transformation of some commercial parcels into City parks (including the cleanup of a contaminated site at Houghton Beach Park); and
- preservation and protection of Yarrow Bay and Juanita Bay wetlands.

Most of the uses, developments, and activities regulated in the City's SMP, Ordinance 3153, are also subject to the City's Comprehensive Plan, the Kirkland Zoning Code, the International Building Code and various other provisions of city, state and federal laws. The applicant must comply with all applicable laws prior to commencing any use, development, or activity. Kirkland ensures consistency between the SMP and other City codes, plans and programs by reviewing each for consistency during periodic updates of the City's Comprehensive Plan as required by State statute.

The Kirkland Zoning Code (KZC), Ordinance 3719, as amended, establishes specific and detailed regulations for most of the uses, development, and activities regulated in the SMP. The KZC and the SMP are intended to operate together to produce coherent and thorough shoreline regulations. In all cases, uses, developments, and activities must comply with both the KZC and the SMP. If there is a conflict between the two, the more restrictive applies.

In the early 1990s, Kirkland adopted regulations to designate and protect critical areas pursuant to the Washington State Growth Management Act (GMA) (RCW 36.70A). In response to later GMA amendments, the City adopted in April 2003 a revised Critical Areas Ordinance (CAO) contained in the KZC consistent with best available science and all other requirements of the GMA. All activities which require a substantial development permit, conditional use or variance under the SMP are reviewed under the City's CAO for consistency. As stated above, if there is a conflict between the CAO and SMP, the regulations that offer the greatest environmental protection apply.

In 1995, the City completed a major update of the Kirkland Comprehensive Plan pursuant to Growth Management Act requirements. Additional minor amendments have been made to the Comprehensive Plan since 1995, most recently in 2005. The KZC is consistent with and implements the Comprehensive Plan.

In addition, the current Kirkland SMP states the intent to be consistent with the Lake Washington Regional Shoreline Goals and Policies as promulgated October 31, 1973 pursuant to WAC Chapter 173-28, which established Lake Washington as a region pursuant to the state Shoreline Management Act. However, if there is a conflict between the two, the City's SMP applies.

The following table (Table 1) summarizes 16 years of shoreline permit applications submitted to the City of Kirkland. Several projects had multiple components and obtained multiple permits; the available permit summary did not consistently indicate which permit type was granted so there are a number of “unknowns.” This summary likely underestimates shoreline activity, as shoreline exemptions were not tracked.

Table 1. Shoreline Permit History in the City of Kirkland Since 1991.

Year	# of Cases	Pier		Bulkhead Mod.	Upland Structure	Upland Park Mod.	Utilities	Permit Type			
		Extension/ Mod.	New/ Replacement					SDP	SCUP	Variance	Unknown
1991	1				1					1	
1992	5	2	1	1	1	1	1	4	1	1	1
1993	4		3		1			3		1	
1994	3	1	1	1	1			1	1		1
1995	9	1	1		4	1	2	4			5
1996	4		2	1	1		1	2		1	1
1997	4	2			1		1	4			
1998	5	1	1	1	4			3		3	1
1999	6	1	4		1			4		1	1
2000	4	1	1		1		1	2			2
2001	3				3					1	2
2002	2				1		1			1	1
2003	2				2						2
2004	5		2		2		1	3			2
2005	4	1	1	1		1		1			3
2006	3	3			1			1			
TOTAL	**64**	**13**	**17**	**5**	**25**	**3**	**8**	**32**	**2**	**9**	**22**

SDP = Shoreline Substantial Development, SCUP = Shoreline Conditional Use Permit

No trends in shoreline activity or permit type are apparent. Over the past 16 years, 26 percent of permitted shoreline projects included a new or replacement pier component, 20 percent a pier extension or modification component, 8 percent a bulkhead modification component, 39 percent an upland structure component (for new commercial or residential construction, setback variances, etc.), 13 percent a utilities component (sewer lines, sewer lift stations, storm drain outfall dredging, etc.), and 5 percent a parks component (trails, hard landscape elements, benches, etc.). Case notes indicate that pier proposals began to include impact minimization measures, such as deck grating and narrow walkways, prescribed by state and federal agencies in 2000. Although not indicated, it is likely that several of the 1999 pier proposals included minimization measures as well, consistent with the listing of chinook salmon and bull trout as Threatened under the federal Endangered Species Act in 1999.

2.2 STATE AND FEDERAL REGULATIONS

State and federal regulations most pertinent to development in the City's shorelines include the federal Endangered Species Act, the federal Clean Water Act, the state Shoreline Management Act, and the State Hydraulic Code. Other relevant federal laws include the National Environmental Policy Act, Anadromous Fish Conservation Act, Clean Air Act, and the Migratory Bird Treaty Act. Other relevant state laws include the Growth Management Act, State Environmental Policy Act, tribal agreements and case law, Watershed Planning Act, Water Resources Act, Salmon Recovery Act, and the Water Quality Protection Act. A variety of agencies (e.g., U.S. Army Corps of Engineers, National Marine Fisheries Service, U.S. Fish and Wildlife Service, Washington Department of Ecology, Washington Department of Fish and Wildlife) are involved in implementing these regulations, but review by these agencies of shoreline development in most cases would be triggered by in- or over-water work, discharges of fill or pollutants into the water, or substantial land clearing. Depending on the nature of the proposed development, state and federal regulations can play an important role in the design and implementation of a shoreline project, ensuring that impacts to shoreline functions and values are avoided, minimized, and/or mitigated. With the comprehensive SMP update, the City will strive to ensure that Kirkland's SMP regulations are consistent with other agencies' requirements and explore ways to streamline the shoreline permitting process. A summary of some of the key regulations and agency responsibilities follows.

<u>Section 10</u>: Section 10 of the federal Rivers and Harbors Appropriation Act of 1899 provides the U.S. Army Corps of Engineers (Corps) with authority to regulate activities that may affect navigation of "navigable" waters. Lake Washington is a designated navigable water. Accordingly, proposals to construct new or modify existing in-water structures (including piers, marinas, bulkheads, breakwaters), to excavate or fill, or to "alter or modify the course, location, condition, or capacity of" Lake Washington must be reviewed and approved by the Corps.

<u>Section 404</u>: Section 404 of the federal Clean Water Act provides the Corps, under the oversight of the U.S. Environmental Protection Agency, with authority to regulate "discharge of dredged or fill material into waters of the United States, including wetlands" (http://www.epa.gov/owow/wetlands/pdf/reg_authority_pr.pdf). The extent of the Corps' authority and the definition of fill have been the subject of considerable legal activity. As applicable to the City of Kirkland's shoreline jurisdiction, however, it generally means that the Corps must review and approve most activities in streams, wetlands and Lake Washington. These activities may include wetland fills, stream and wetland restoration, and culvert installation or replacement, among others. Similar to SEPA requirements, the Corps is interested in avoidance, minimization, restoration, and compensation of impacts.

<u>Federal Endangered Species Act (ESA)</u>: Section 9 of the ESA prohibits "take" of listed species. Take has been defined in Section 3 as: "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." The take prohibitions of the ESA apply to everyone, so any action of the City that results in a take of listed fish or wildlife would be a violation of the ESA and exposes the City to risk of lawsuit. Per Section 7 of the ESA, activities with potential to affect federally listed or proposed species and that either require federal approval, receive federal funding, or occur on federal land must be reviewed by the National Marine Fisheries Service (NOAA Fisheries) and/or U.S. Fish and Wildlife Service

(USFWS) via a process called "consultation." As previously mentioned, a Corps permit under Section 10 of the Rivers and Harbors Appropriation Act is required for projects in Lake Washington. Since the listing of chinook salmon and bull trout as Threatened under the ESA, the Corps, NOAA Fisheries and USFWS have jointly developed extensive guidance for design of Lake Washington pier and bulkhead projects.

Section 401 Water Quality Certification: Section 401 of the federal Clean Water Act allows states to review, condition, and approve or deny certain federal permitted actions that result in discharges to state waters, including wetlands. In Washington, the Department of Ecology is the state agency responsible for conducting that review, with their primary review criteria of ensuring that state water quality standards are met. Actions within Lake Washington, or wetlands and streams within the shoreline zone that require a Section 10 or Section 404 permit (see above), will also need to be reviewed by Ecology.

Hydraulic Code: Chapter 77.55 RCW (the Hydraulic Code) gives the Washington Department of Fish and Wildlife (WDFW) the authority to review, condition, and approve or deny "any construction activity that will use, divert, obstruct, or change the bed or flow of state waters." As applicable to the City of Kirkland's shoreline jurisdiction, however, it generally means that WDFW must review and approve most activities in streams and Lake Washington. These activities may include stream alteration, culvert installation or replacement, pier and bulkhead repair or construction, among others. WDFW can condition projects to avoid, minimize, restore, and compensate adverse impacts.

3.0 SHORELINE INVENTORY

The following discussion identifies each of the required inventory elements, sources of information for each element, and provides a City-wide or shoreline-wide narrative for each element. Segment-specific discussions, as needed, can be found in Section 4.0 and photographs are included in Appendix C. Four segments have been established (A through D, Figure 1b), and have been delineated based on existing land use and current location within either the City or the PAA (Table 2). Segment A is the northernmost segment, comprising the PAA that is anticipated for annexation from King County in the next several years. It is almost entirely residential, with one large park (O.O. Denny Park). Segment B consists of two high-functioning natural areas that are primarily zoned as Park/Open Space: Juanita Bay with its associated wetlands and a portion of Forbes Creek and Juanita Creek, and Yarrow Bay with its associated wetlands and portions of Yarrow Creek and Cochran Springs Creek. Segment C consists of the primarily single-family residential areas within the City limits and a few parks. Segment D consists of the more urban areas within the City limits, including the Central Business District, areas zoned for medium- to high-density residential and commercial uses, and a few developed parks. Segments B, A/C and D have distinct characters based not only on their existing zoning and current land use, but also different levels of shoreline modifications (piers and type/amount of shoreline hardening), impervious surface, and shoreline vegetation. These characteristics are indicators of relative ecological function.

Table 2. Shoreline Planning Segments.

Segment	Approximate Length (feet / miles)	Approximate Area (acres / sq. miles)
A PAA	20,491 / 3.9	88.4 / 0.14
B Juanita Bay and Yarrow Bay Park/Wetlands	10,633 / 2.0	139.5 / 0.22
C Residential	9,363 / 1.8	40.8 / 0.06
D Urban	12,242 / 2.3	53.4 / 0.08
City Subtotal (Segments B-D)	**32,238 / 6.1**	**233.7 / 0.37**
TOTAL	**52,729 / 9.9**	**322.1 / 0.5**

3.1 LAND USE PATTERNS

3.1.1 Existing Land Use

Land use patterns were derived from GIS mapping from the City's most recent Comprehensive Plan (Figures 3a, 3b and 3c) (City of Kirkland 2004), from review of aerial photography from 2005, and the King County Comprehensive Plan (King County 2004). In general, the City of Kirkland shoreline area is fully developed, with existing land uses largely consistent with planned land uses as illustrated in the Comprehensive Plan. Areas not occupied by residential or commercial/office development are either formal and informal City parks and open spaces, or large wetland areas. Very few undeveloped lots remain within shoreline jurisdiction (see Table 3). The majority of these undeveloped lots are located within the PAA (32 lots), compared with 24, 2 and 6 in Segments B, C and D, respectively. In Segment B, the relatively large number of undeveloped lots (24) is due to a number of lots along the southwest corner of the Yarrow Bay wetlands. These figures indicate that only 9 percent of all properties within the shoreline area are vacant. This also illustrates that if future development occurs, it will likely be in the form of redevelopment consistent with adopted plans and regulations. Except for a few anomalies, discussed in Section 4.2.1 below, the high-functioning portions of the shoreline have been appropriately designated and preserved as park/open space. Land uses along the shoreline are only expected to change minimally, if at all, although re-builds, substantial remodels, and some redevelopment of one type of commercial into another type of commercial, multi-family or mixed use are anticipated. More detailed descriptions of each segment can be found in Section 4.0 below.

Table 3. Development Condition and Setbacks on Waterfront Parcels

Segment		# of Lots	Vacant/ Undeveloped Lots	% Vacant	Average Structure Setback on Developed Waterfront Lots	Current Minimum Setback per SMP
A	PAA	344	32	9%	90 ft	20’
B	Juanita Bay and Yarrow Bay Park/Wetlands	91	24	26%	821 ft	Juanita Bay: 15’ or 15% of average parcel depth, whichever is greater Yarrow Bay: 100’ from Lake WA and 50’ from canal
C	Residential	117	2	2%	56’	15’ or 15% of average parcel depth, whichever is greater
D	Urban	128	6	5%	35’	15’ or 15% of average parcel depth, whichever is greater
	City Subtotal (Segments B-D)	**336**	**32**	**10%**	**255’**	
	TOTAL	**680**	**64**	**9%**	**98 or 72**[1]	

[1] 98’ was calculated including Segment B, which inappropriately skews the results. 72’ was calculated without Segment B, which yields a better estimate of average existing structure setback in the developed waterfront segments.

3.1.2 Shoreline Demand and Redevelopment Potential

Pursuant to the State’s Growth Management Act, Kirkland periodically undertakes a City-wide capacity analysis for residential (single-family and multi-family) and specific non-residential uses (retail, office and industrial). Based on established assumptions, capacity numbers are generated to determine the redevelopment potential. Capacity calculations are estimates and not predictions. In addition, they change over time – particularly as a result of new zoning or changes to the land values or improvement values.

Within the shoreline area, a capacity analysis was undertaken to estimate the potential for redevelopment within each segment. This analysis will contribute to establishment of shoreline designations, as well as document the demand for shoreline space, development activity and potential use conflicts.

Tables 4 and 5 show the capacity analysis results for residential use and retail/office space use by segment. There is no industrial use within the shoreline area. Information for Segment A, the PAA in unincorporated King County, is not available at this time. However, since it is a single-family residential area, little change is expected other than some new single-family construction or remodeling of existing units.

Table 4. Residential Capacity

Segment	Existing SF Units	Added SF Units	SF Units Capacity	Existing MF Units	Added MF Units	MF Units Capacity
B Juanita Bay and Yarrow Bay Park/Wetlands	3	25	28	165	48	213
C Residential	117	13	130	16	0	16
D Urban	23	-4	19	1213	401	1614
TOTAL	**143**	**34**	**177**	**1394**	**449**	**1843**

Table 5. Non-Residential Capacity*

Segment	Existing Retail	Added Retail	Retail Capacity	Existing Office	Added Office	Office Capacity
B Juanita Bay and Yarrow Bay Park/Wetlands	49,258	7,610	56,868	443,228	13,385	456,613
C Residential	NA			NA		
D Urban	125,923	50,626	176,549	969,562	82,482	1,052.044
TOTAL	**175,181**	**58,236**	**233,417**	**1,412,790**	**95,867**	**1,508.657**

*All numbers are square feet.

As redevelopment does occur, commercial and multi-family uses must provide public pedestrian access from the right-of-way to and along the waterfront. Along with public access, redevelopment could result in opportunities for shoreline improvement to reduce conflicts.

3.2 TRANSPORTATION

There are very few major arterial road sections in shoreline jurisdiction (Figures 1-3). Portions of Lake Washington Boulevard NE/Lake Street South are parallel to and within shoreline jurisdiction in the urban area (Segment D). The only other major road within the shoreline is Market Street/98th Avenue NE, which crosses shoreline jurisdiction through the Forbes Creek corridor (Segment B). In the PAA, Holmes Point Drive NE is parallel to and within shoreline jurisdiction; however, it is used primarily by local residents and is not a major commuting corridor. Otherwise, roadways are limited to minor drives that each provide access off of these roads to a few homes or businesses.

3.3 WASTEWATER AND STORMWATER UTILITIES

There are two primary utilities with the ability to directly and indirectly impact State shorelines: wastewater and stormwater.

3.3.1 Wastewater Utilities

The City provides sewer services to areas south of NE 116th Street, and Northshore Utility District provides services to areas north of NE 116th Street, including the PAA. King County Natural Resources and Parks Wastewater Treatment Division (formerly known as Metro) treats wastewater from both service providers at either the South or West Point Treatment Plants. Both treatment plants, located in Renton and Seattle, respectively, discharge into Puget Sound after providing primary, secondary, and disinfection treatments. Discharges from these plants are regulated by the Washington Department of Ecology under National Pollutant Discharge Elimination System (NPDES) permits, which includes performance standards and monitoring requirements. Most of the shoreline area includes a sewer line parallel to Lake Washington, so repair work or line failures could directly impact Lake Washington water quality.

Metro was established in 1958 to eliminate wastewater discharges into Lake Washington that had such a profound adverse effect on water quality and habitat. By 1968, discharges of untreated sewage, which were once about 20 million gallons per day, had dropped to 0 (except for combined sewer overflows) and water quality in the lake rapidly and dramatically improved (Li *unknown date*; Edmondson 1991). As part of the sewage overhaul, Metro constructed the two treatment plants previously mentioned, and over 100 miles of trunk lines and interceptors. The trunk lines run along the perimeter of Lake Washington, in and outside of the lake. Combined sewer overflows (CSOs) still occur within City of Seattle jurisdiction during high rain events, but the incidence and overall volumes are being reduced. King County recently completed its final and largest Lake Washington CSO project in the Rainier Beach area. Prior to implementation of this project in late 2005, CSO volumes into Lake Washington were between 30 and 60 million gallons per year. Figures 4a and 4b shows the locations of all sewer lines within shoreline jurisdiction; shoreline modification projects and any upland development project should locate all lines prior to construction to avoid damaging the lines, incurring biological impacts, during construction. The potential exists for routine repair and maintenance or line failures to result in short-term discharges of sewage into the lake.

3.3.2 Stormwater Utilities

The City of Kirkland established a Surface Water Utility in 1998 “with the primary purpose of operating and maintaining the City’s surface water system, which includes constructed elements such as pipes and catch basins, and natural resources such as streams and lakes” (City of Kirkland 2005a). Although much of the Utility’s jurisdiction is outside of the shoreline zone, all of the regulated surface waters, both natural and piped, are discharged ultimately into Lake Washington and thus affect shoreline conditions. There are more than 70 outfalls directly into the shoreline area, and many more that discharge just outside of shoreline jurisdiction, but subsequently flow into the shoreline area (see Figures 5a and 5b). The 2005 *Surface Water Master Plan* contains the following goals:

> Flood Reduction – minimize existing flooding and prevent increase in future flooding through construction of projects that address existing problems, increased inspection and rehabilitation of the existing system, and increased public education.
>
> Water Quality Improvement - increase efforts to maintain and improve water quality by increasing public education (source control), identifying pollution “hot spots” for possible water quality treatment and by examining City practices and facilities to identify where water quality improvements could be achieved.
>
> Aquatic Habitat – increase efforts to slow the decline of aquatic habitat and create improved conditions that will sustain existing fish populations. Combine hydrological

controls, such as regional detention, with in-stream habitat improvement projects in Juanita and Forbes creeks watersheds that currently support fish populations.

The *Surface Water Master Plan* will grow and change with community and City priorities. A formal update will likely occur about once every five years. Since preparation of the first *Surface Water Master Plan* in 1994, the Utility has accomplished a number of actions that further achieve its goals (excerpted from the 2005 *Surface Water Master Plan*).

Flood Reduction

- Eliminated most major flooding problems.
- Mapped surface water infrastructure.
- Implemented a program to inspect and clear flooding "hot spots" during storm events

Water Quality

- Adopted an ordinance to prohibit illicit discharges (spills and dumping), require use of pollution prevention practices, require maintenance of private drainage facilities, and require pre- and post-development control of stormwater runoff.
- Established a water quality monitoring program.[1]
- Implemented a volunteer program to conduct water quality monitoring, planting of native vegetation, and other activities.
- Increased frequency of system cleaning, resulting in removal of an average of 200 cubic yards of sediment per year
- Conducted regional water quality related outreach programs in Kirkland, including "Natural Yard Care" and "Horses for Clean Water."
- Distributed educational brochures regarding pollution prevention, car washing practices, and leaf blower use.
- Conducted storm drain stenciling with community groups.

The City will receive its final National Pollutant Discharge Elimination System (NPDES) Phase II permit in December 2006 from Ecology. The NPDES Phase II permit is required to cover the City's stormwater discharges into regulated lakes and streams. Under the conditions of the permit, the City must protect and improve water quality through public education and outreach, detection and elimination of illicit non-stormwater discharges (e.g., spills, illegal dumping, wastewater), management and regulation of construction site runoff, management and regulation of runoff from new development and redevelopment, and pollution prevention and maintenance for municipal operations.

The City conducts all of the above at some level already, but significant additional effort may be needed to "document activities and to alter or upgrade programs" (City of Kirkland 2005). The City has various programs to control stormwater pollution through maintenance of public facilities, inspection of private facilities, water quality treatment requirements for new

[1] The City conducted water quality monitoring for basic parameters (temperature, pH, dissolved oxygen, turbidity, fecal coliform, and others) at seven sites on Forbes Creek from 2002-2003. Monitoring was also conducted on Forbes Lake in summers of 2004 and 2006. King County has conducted water quality monitoring on Juanita Creek and at the mouth of Forbes Creek. King County also conducts extensive monitoring of water quality in Lake Washington.

development, source control work with businesses and residents, and spill control and response. Monitoring may be required as part of an illicit discharge detection and elimination program, for certain construction sites, or in waterbodies with a Total Maximum Daily Load (TMDL) Plan for particular pollutants. General water quality monitoring was not required in the first five-year term of the draft Phase II permit that was issued in summer 2006; however, the draft permit asks municipalities to assist in development of a monitoring program that will be implemented during the second five-year permit term. General water quality monitoring concerns include a) stormwater quality, b) effectiveness of best management practices, and c) effectiveness of the stormwater management program.

The City currently follows the *1998 King County Surface Water Design Manual*, but will be asking the City Council to approve a switch to Ecology's 2005 *Stormwater Management Manual for Western Washington* as the NPDES Phase II permit requires that the City use minimum requirements that are equivalent to this manual. The purpose of stormwater detention is to reduce flooding of roads and structures, and to reduce damage to stream channels (and associated fish habitat) that results from the more frequent and longer duration peak flows that come from developed watersheds. Large lakes such as Lake Washington are not subject to damage from peak flows, and so detention is not required for projects draining directly to them. In addition, the lake level is managed and maintained by the Corps, which further reduces flooding potential.

However, discharges into the tributary streams, such as Forbes Creek, can have a significant impact on in-stream habitat complexity, peak flow magnitude and duration, bank stability, substrate composition, and a number of other parameters. The water quality impact of stormwater inputs is also significant. Stormwater runoff carries pesticides, herbicides and fertilizers applied to lawns and sports fields; hydrocarbons and metals from vehicles; and sediments from construction sites, among other things. All of these things can harm fish and wildlife, their habitats, and humans. Per current standards, water quality treatment is required when 5,000 square feet or greater of "pollution generating" impervious surface (driveways, parking areas) is created or replaced, regardless of whether the system drains to a lake or a stream. The City is also in the process of evaluating which areas of the City have the most potential for generating stormwater pollution, and will be identifying treatment and source control options for those areas. This work will be complete in the first half of 2007.

3.4 IMPERVIOUS SURFACES

The City of Kirkland originally mapped impervious surface area in the entire City, including shoreline jurisdiction, in 1999 from black and white aerial photographs and updated the maps in 2002 from color aerial photographs (Figures 6a-b, Table 6) (City of Kirkland 2003). The City obtained impervious surface data for the PAA from the Northshore Utility District in 2002. This summation includes roads, parking lots, and rooftops, but does not include reduced perviousness caused by compaction or vegetative changes. As expected, Segment B, which includes Juanita Beach Park, Juanita Bay Park, Forbes Creek, and the Yarrow Bay Wetlands, has the lowest percentage of impervious surface (3%). Conversely, higher percentages are found in the residential (Segments A and C are about 29%) and commercial areas (Segment D equals 55%).

Table 6. Total Impervious Surface within Each Segment.

Segment	Total Impervious Area within the Segment	% Impervious Surface within the Segment
A PAA	24.4 acres	28.8[1]
B Juanita Bay and Yarrow Bay Park/Wetlands	4.63 acres	3.3
C Residential	11.84 acres	29.0
D Urban	29.61 acres	55.5
City Subtotal (Segments B-D)	**46.08 acres**	**19.7**
TOTAL	**70.48 acres**	**21.9**

[1] King County's mapping of impervious surface in the PAA is based off of a raster data set that consists of 30'x30' squares. Better mapping from 2002 was obtained from the Northshore Utility District.

Impervious surface is relevant to shoreline functions because of the relationship between impervious surfaces and stormwater runoff. In a number of ways, vegetated areas slow the movement and reduce the quantity of runoff that makes its way into streams and other waterbodies. Increases in impervious surface coverage, and the consequent reduction in soil infiltration, have been correlated with increased velocity, volume and frequency of surface water flows. This hydrologic shift alters sediment and pollutant delivery to streams and other receiving bodies (Booth 1998; Arnold and Gibbons 1996). Increased surface water flows associated with impervious surface coverage of suburban areas (20-30%) has been linked to decreased bank stability and increased erosion (May et al. 1997a). Rainwater can evaporate off of vegetation without ever reaching the ground, infiltrate into the soils where it is taken up by vegetation and evapotranspirated, infiltrate into the soils to recharge groundwater, or move slowly over the surface or subsurface into a waterbody. Impervious surfaces replace vegetation and speed the movement of runoff into waterbodies while increasing the volume of the runoff, and may pick up pollutants in the process.

One proactive step the City is taking to reduce the impact of its impervious surfaces is implementation of its Green Kirkland program and other efforts to increase tree canopy cover. As mentioned above, vegetation can reduce volumes or velocities of rainwater that turns into stormwater runoff. According to the *City of Kirkland Natural Resource Management Plan* (2003), current canopy cover is at 32 percent. The City's goal is to increase City-wide tree cover to 40 percent, consistent with recommendations in a report by American Forests (1998, cited in City of Kirkland 2003) that suggests that an average tree cover of 40 percent in the urban areas of Puget Sound could reduce stormwater management needs and improve air quality. In 2005, the Parks and Community Services Department planted over 100 trees, a mix of native and non-native species, in City parks and rights-of-way. In fall 2006, the Department provided over 50 free trees to the public that were funded by tree ordinance fines. Tree preservation and planting, as well as invasive species control, are priorities in City parks.

3.5 SHORELINE MODIFICATIONS

Shoreline modifications are anthropogenic alterations to the natural lake edge and nearshore environments, and primarily include a variety of armoring types (some associated with fill), piers, and other in-water structures such as boatlifts, boathouses, and moorage covers. These sorts of modifications alter the function of the lake edge, change erosion and sediment movement patterns, affect the distribution of aquatic vegetation, and are often accompanied by upland vegetation loss.

Shoreline armoring can have many justifications, but often the intent of bulkheads is to:

- protect shoreline property by reducing wave impacts and decreasing erosion,
- increase or maintain lawn areas, and/or
- coordinate style of neighboring shoreline properties.

While not all bulkheads are necessary to protect shoreline property from excessive erosion, there are many areas along the City's shoreline and within the PAA, especially on shallow lots with steep banks, that may need some form of shoreline armoring in order to protect existing structures and land uses. The topography along the City's waterfront varies widely from shallow, low-gradient shorelines around Yarrow and Juanita Bays to more steep-gradient shorelines along the urban areas of Segment D and some residential areas along Segment C. Some of these topographic differences result from the lowering of the lake by 9 feet in 1916 during construction of the Hiram Chittenden Locks, where some shallow water areas gave way to steep drop-offs. Historically, shoreline armoring constituted the use of concrete walls, large boulders, and wood timbers. However, many bioengineering techniques have been developed in recent years to provide alternative shoreline protection methods.

Chemical treatments of pier components, such as creosote piles, installed prior to today's standards, have also impacted water and sediment quality in the lake. These specific shoreline functions and the related effects of shoreline modifications are discussed in greater detail in Section 5.1 below.

A combination of recent aerial photographs and a field inventory conducted by boat in March 2006 were used to collect information about shoreline modifications in the City and the PAA (Figures 7a through 7e, Tables 7 and 8).

As expected, the urban segment (Segment D) has the most altered shoreline, with 90 percent armored with either vertical or boulder bulkheads, and Juanita and Yarrow Bays (Segment B) have the least altered shorelines, with only 7 percent armoring. The residential segments (Segments A and C) are 76 and 83 percent armored, respectively.

Also as expected, the highest amount of overwater cover per lineal foot of shoreline can be found in Segment D, which is nearly triple the amount of cover found in the residential segments (A and C). This can be attributed to the presence of several marinas, large park-associated piers, multiple large piers that serve condominiums, and a couple of over-water condominiums. However, the total number of individual pier/dock structures in the urban segment is about half of that in the residential segments, due to the abundance of single-family residential pier structures. Segment B had the lowest area of overwater cover and the lowest number of overwater structures.

Table 7. Lake Edge Condition within Each Segment.

Segment		Lake Edge Condition (feet / % of segment)		
		Vertical[1]	Boulder[2]	Natural / Semi-Natural[3]
A	PAA	8,063 39%	7,603 37%	4,826 24%
B	Juanita Bay and Yarrow Bay Park/Wetlands	317 3%	461 4%	9,855 93%
C	Residential	4,919 53%	2,793 30%	1,652 18%
D	Urban	5,145 42%	5,831 48%	1,266 10%
City Subtotal (Segments B-D)		**10,381** **32%**	**9,085** **28%**	**12,773** **40%**
TOTAL (percent of total length)		**18,444** **35%**	**16,688** **32%**	**17,599** **33%**

[1] "Vertical" shorelines encompass concrete, wood and mortared boulder armoring types. The key characteristic, besides a generally vertical orientation, is the lack of interstitial spaces in the face of the bulkhead that could provide some habitat.
[2] "Boulder" shorelines are typically angular or rounded granite or basalt. They may be vertical or sloped, but they all contain interstitial spaces, which provide some habitat and may absorb or attenuate some wave energy.
[3] "Natural/Semi-Natural" shorelines captures those areas that are not solidly armored at the ordinary high water line; they may include some scattered boulders or woody debris at or near the ordinary high water line. Except in areas of Segment B, "natural/semi-natural" designation is not intended to describe the environmental condition upland of ordinary high water.

Table 8. Overwater Cover within Each Segment.[1]

Segment	Single-Family Docks		Multi-Family Docks and Condos		Commercial Docks (Marinas)		Public Park Docks		Total Cover (SF)	Cover/ Lineal Foot	# of Overwater Structures/ Mile
	#	Area (SF)	#	Area (SF)	#	Area (SF)	#	Area (SF)			
A	213	182,394	0	0	0	0	0	0	182,394	8.9	54.9
B	0	0	1	1,577	0	0	3	14,231	16,464	1.5	2.0
C	90	73,581	2	4,612	0	0	1	6,077	84,270	9.0	52.4
D	21	19,803	26	130,132	11	133,515	5	11,909	295,359	24.1	27.2
City Sub-total	**111**	**93,385**	**29**	**136,322**	**11**	**133,515**	**9**	**32,218**	**395,440**	**12.3**	**26.2**
TOTAL	**324**	**275,779**	**29**	**136,322**	**11**	**133,515**	**9**	**32,218**	**577,834**	**11.0**	**37.4**

[1] Overwater cover calculations include piers and docks, but also includes areas of covered moorage, boathouses, and overwater condominiums/apartments.

Both measures, total overwater cover and number of structures, are relevant to ecological function assessment. Total overwater cover is an indication of the amount of lake surface that is shaded, which can impact growth of aquatic vegetation and subsequently the food chain as a whole. Overwater cover is also implicated in exacerbating the predator-prey relationship between native fish and non-native fish, particularly between threatened chinook salmon and other salmonids and introduced bass (Fresh et al. 2003; Tabor et al. 2004a). The number of structures is relevant as it indicates the number of impedances to juvenile salmon migration along the shoreline. Studies have indicated that juvenile salmon approaching a sharp change in light and cover may attempt to go around the structure, which increases predation risk (Tabor et al. 2006). For additional discussion of the potential biological impacts of cover and structure, see Chapter 5.2.

3.6 EXISTING AND POTENTIAL PUBLIC ACCESS SITES

Information about public access sites in the City was drawn from site visits, aerial photographs, and City mapping of formal parks, open space, street-ends, and the trail system (Figure 8). Developing public shoreline access to the shoreline area is a priority of the City, as evidenced by the goals and policies included in the Public Access element of the City's 1989 SMP. Except for single-family residential areas or environmentally sensitive areas, the SMP requires that all development provide public access to the water's edge and along the shoreline as much as possible. The City has made significant progress towards establishing continuous pedestrian access along the water's edge in Segment D as many of the multi-family and commercial properties have redeveloped. Appendix D includes a City template for a public access easement agreement.

The amount of area zoned or designated as park/open space within each segment is one measure of the existing public access opportunity, and is summarized in Table 9. The City has approximately 6.8 miles of trails within shoreline jurisdiction. The trails and parks combined provide 2.5 miles of public waterfront access.

Juanita Beach Park is one of the City's largest multi-use parks located on the Lake Washington waterfront. The City commissioned the *Juanita Beach Park Draft Master Plan Report* (J.A. Brennan Associates, PLLC 2005) after assuming ownership from King County in 2002. The *Master Plan Report* includes goals for a number of areas, including environmental stewardship and recreation. The plan addresses potential day boat moorage, swimming beach improvements (to address water and sediment quality and excessive sediment deposition), a new non-motorized boat rental facility, hand-carried boat launch, and restoration of Juanita Creek, its buffer, and wetlands.

Additional opportunities for public access will arise with each re-development proposal. The City is anxious to continue development of the connected trail system along the shoreline. As funding allows, street-ends, other City rights-of-way, and other opportunities may also be formally added to the public access system. As well, the City should consider purchasing and formally designating the undeveloped lots between the west edge of the Yarrow Bay Wetlands and City limits as park/open space.

Table 9. Park/Open Space Area within Shoreline Jurisdiction by Segment.

Segment	Area of Park/Open Space	% of Segment	Other Access Notes
A PAA	7 acres	8%	Although not zoned by King County as open space, this segment includes O.O. Denny Park, which includes mostly passive recreation in the shoreline zone
B Juanita Bay and Yarrow Bay Park/Wetlands	120.3 acres	86%	Major park and natural wetland areas with multiple use types, including both passive and active recreation
C Residential	9.95 acres	24%	Primarily fully developed parks
D Urban	9.41 acres	18%	Numerous small, fully developed parks in addition to an extensive trail system
City Subtotal (Segments B-D)	**132.7**	**57%**	
TOTAL	**139.7 acres**	**43% of total shoreline area**	

3.7 CRITICAL AREAS

The inventory of critical areas was based on a wide range of information sources. A complete listing of citations used to compile information on critical areas is included in Section 7.0 at the end of this study.

Geologically Hazardous Areas: The City's mapping of landslide and seismic hazard areas was derived from data prepared for the City by King County in 1991 (City of Kirkland 2003) (Figure 12). Presumably, King County based those designations on topographic information and soil types as cataloged by the Natural Resources Conservation Service (NRCS) (see Figure 9).

Frequently Flooded Areas: For all practical purposes, "frequently flooded areas" are those areas within the 100-year floodplain. Lake Washington does not have a floodplain, but portions of Forbes Creek and the Yarrow Bay wetland (Segment B) within shoreline jurisdiction are mapped as 100-year floodplain per Federal Emergency Management Agency maps (FEMA 1995) (Figure 10). These maps show areas with the potential for at least one foot of flooding. Both the Forbes Creek area and the Yarrow Bay Wetlands area contain low-gradient portions of stream channels in which the streambanks are readily overtopped during heavy storm events.

Wetlands: Wetland mapping within the City limits was updated in 1999, pursuant to a detailed inventory commissioned by the City. Subsequent minor map updates have occurred, with the latest adopted in 2004. Wetland mapping within the PAA is derived from King County GIS. Both mapping efforts used a combination of soils mapping, aerial photographs (see vegetation mapping in Figures 14 a-b), National Wetland Inventory maps, submitted reports, and some field inventory (Figure 11). Soils mapped by the NRCS are shown on Figure 9. Soil types classified as "hydric" are indicative of wetland soils; six hydric soil types were mapped in portions of shoreline jurisdiction in the City limits and the PAA.

Streams: Several streams pass through the City of Kirkland and its PAA, discharging into Lake Washington (Figure 13). Information regarding each stream was gathered from WDFW's Priority Habitats and Species (PHS) maps and reports (WDFW 2006), WRIA 8 map products (King County DNR 2001), and a City-wide study of critical areas (The Watershed Company 1998). Several of these streams are known to support fish use, including chinook (juvenile use of the mouths of several streams), coho, and sockeye salmon and cutthroat trout. Some of the more prominent fish-bearing streams include Yarrow Creek, Forbes Creek, and Juanita Creek. However, salmonid and other fish species are known to inhabit other smaller Lake Washington tributaries such as Carillon Creek and Denny Creek. Many of the smaller tributaries to Lake Washington originate as hillside seeps or springs and flow seasonally or during periods of heavy rains. Many of these smaller systems are piped at some point and discharge directly to Lake Washington via a closed system.

Other Fish and Wildlife Habitat Conservation Areas: WDFW mapping of Priority Habitat and Species also indicates the presence of other Fish and Wildlife Habitat Conservation Areas within and adjacent to the shoreline zone (Figure 13). These include pileated woodpecker breeding areas, historic and current bald eagle nest locations, great blue heron nest colony, wetlands, urban natural open space, and riparian zones.

Critical Aquifer Recharge Areas: No critical aquifer recharge areas are mapped within the City or the PAA.

3.8 FLOODPLAINS AND CHANNEL MIGRATION ZONES

Floodplain boundaries were developed from the FEMA FIRM[1] and the City's GIS mapping (Figure 10). As noted above, Lake Washington does not have a floodplain due to its lake elevation control by the Corps. However, floodplains are designated for both Yarrow Creek Wetlands and low-gradient riparian area associated with Forbes Creek. Channel migration is not relevant in lake systems. However, both Yarrow Creek and Forbes Creek have the potential for slight channel migration along their downstream segments near their outfall into Lake Washington.

Yarrow Creek flows in a broad flat valley with wetland encompassing the valley bottom. This deltaic portion of Yarrow Creek may migrate within this valley bottom, but the potential for migration is limited by the valley walls, which correspond to the edge of the wetland.

Forbes Creek migration is limited by several factors. Upstream of Market Street, the stream is in a steep-walled valley with a broad, relatively flat bottom. The entire valley bottom is wetland associated with Lake Washington and the creek. The potential channel migration zone therefore is limited to the valley bottom, which is already identified and protected as wetland associated with Lake Washington. At Market Street, a primary north-south traffic corridor in Kirkland, channel migration is controlled by the culvert that conveys Forbes Creek under the road.

[1] As suggested by Ecology, the University of Washington's *Puget Sound River History Project* website was reviewed (http://riverhistory.ess.washington.edu/download.php). Lake Washington and its tributary streams were not included in that analysis. As discussed in Jones et al. (1998), FEMA mapping from the 1980s is out-of-date and somewhat unreliable. However, the applicable FEMA map for the City of Kirkland was generated in 1995, and so may be more reliable. More recent data for Yarrow Creek and Forbes Creek could not be located.

Downstream of the road, the potential migration zone of the creek is again encompassed by wetland associated with the Lake.

Though neither creek is of sufficient size to be considered a shoreline waterbody, their channel migration zone has been considered. In both cases, the potential channel migration zone is protected as wetland associated with Lake Washington. This protection limits development and modifications in those areas where the creeks have the potential to migrate. This protection assures no net loss of ecological function, and eliminates potential for migration to affect existing or future structures.

Juanita Creek and its tributaries, located both within the City and the PAA, flow through residential and urban areas where extensive bank protection has virtually eliminated any potential for channel migration. As recent as 1981, only 40 percent of the basin was considered urban/suburban (PSCOG 1981). Since that time, the 4,000-acre Juanita Creek basin has continued to undergo extensive development and is now considered “highly” developed. Juanita Creek does not have a designated floodplain boundary identified on the FEMA FIRM maps.

3.9 HISTORICAL OR ARCHAEOLOGICAL SITES

The City of Kirkland has several special features that are documented by the Washington State Office of Archaeology and Historic Preservation (OAHP) (http://www.oahp.wa.gov/gis/INDEX.CFM). The Tourist II is on the Washington Historical Register and the National Register of Historic Places. It was originally constructed in 1924 as an auto ferry, but is now used by Argosy Cruises to provide tours of Lake Washington from Marina Park. Relief, built in 1904, was one of the first four lightship that guided boats into Pacific Coast ports. She is now moored at Moss Bay Marina as a historic floating museum. The Arthur Foss, the last operational 19th-century wooden-hulled tugboat, is listed by the National Park Service as a National Historic Landmark.

In addition, the Louis Marsh house, a single-family residence on Lake Washington Boulevard, is on the Washington Historical Register and the National Register of Historic Places. According to the registration form (http://www.oahp.wa.gov/gis/pdfs/502.pdf), the Marsh house is “among the most architecturally significant residences along the eastern shore of Lake Washington, and is closely associated with the career of pioneer aviation engineer and philanthropist, Louis Marsh.”

St. Edwards State Park, just north of the PAA boundary, has also been included on the Washington Heritage Register since 1997 as a historic religious institution. In 1931, the Catholic Diocese of Seattle constructed an educational campus to provide a high level of training to would-be Catholic priests. The buildings and grounds, except for the St. Thomas Seminary, were sold to Washington State Parks in 1976.

Although not documented by the OAHP, Juanita Bay was utilized by Native Americans prior to 1830. Until smallpox outbreaks decimated this encampment of the Duwamish tribe, a winter camp was located on Forbes Creek, in what is currently Juanita Bay Park (http://www.parentmap.com/park_archive/park_juanita.htm). Surviving Native Americans continued to harvest wapato (an aquatic plant used for food) from Juanita Creek until the lake level was lowered in 1916, eliminating wapato habitat. The Muckleshoot Tribe also has a long history of using Lake Washington, which is part of the Tribe's Usual and Accustomed Area, particularly for fish harvest to which the Muckleshoot Tribe has established treaty fishing rights (http://www.muckleshoot.nsn.us/history.htm).

3.10 OTHER AREAS OF SPECIAL INTEREST

Areas of special interest not included in the other elements of the inventory, such as priority species use and habitats, rapidly developing waterfronts, eroding shorelines, or other degraded sites with potential for ecological restoration were identified based on the references described above, the results of the field reconnaissance of the study area in March 2006, and citizen input during the September 2006 public involvement efforts by the City.

Information on special status fish and wildlife species and habitat areas was obtained from several sources. Special status species are species that are listed or proposed for listing under the State or Federal Endangered Species Act, identified by WDFW as state Priority Species, or identified by the USFWS as a Species of Concern. Information on Priority Species and general fish and wildlife habitat areas was obtained from the WDFW's Priority Habitats and Species (PHS) data. Information on sensitive species was obtained from websites of the USFWS and NOAA Fisheries.

The City does not have any active toxic or hazardous material clean-up sites or dredged disposal sites. During the field inventory conducting in March 2006, no significant eroding shorelines were noted.

3.10.1 Priority Species

Specific information on fish occurrence and habitat use within the City was provided by the PHS data (WDFW 2006); *Washington State Salmon and Steelhead Stock Inventory* (SASSI) (WDF et al. 1993); the *SASSI Bull Trout/Dolly Varden Appendix* (WDFW 1998); the *Catalog of Washington Streams and Salmon Utilization, Volume 1, Puget Sound Region* (Williams et al. 1975); various maps and reports generated by the WRIA 8 stakeholders; and additional sources as cited in the text.

All game and food fishes, including salmon, trout, and char, are considered to be Priority Species by the Washington Department of Fish and Wildlife (WDFW). In addition, Coastal-Puget Sound bull trout are listed as threatened by the USFWS, Puget Sound chinook salmon are listed as threatened by NOAA Fisheries, and Puget Sound steelhead are proposed for listing as threatened by NOAA Fisheries.

The following special status species have been mapped in or are known to use Kirkland's shoreline jurisdiction (WDFW 2006):

- Bald eagle (nesting, perching and foraging)
- Pileated woodpecker (breeding)
- Great blue heron (colony)
- Dolly Varden/bull trout (limited to occasional straying and/or short-term rearing by juveniles)

- Chinook salmon
- Coho salmon
- Sockeye salmon
- Winter steelhead trout
- Cutthroat trout

3.10.2 Water-Oriented Uses

According to Ecology's SMP Guidelines (173-26-020 WAC), "water-oriented use means a use that is water-dependent, water-related, or water-enjoyment, or a combination of such uses." One public marina and several private marinas are located on the lake within Kirkland. The Kirkland Public Dock is located downtown at Marina Park. Large private marinas include Carillon Point Marina, Yarrow Bay Marina and Kirkland Yacht Club. A couple of these marinas have recently completed, or are in the planning stages, modifications to their over-water facilities, including large breakwaters and additions and reconfigurations of moorage space. Yarrow Bay Marina redevelopment plans have also incorporated a public access/educational component and native shoreline plantings into a small section of shoreline. Slightly smaller private community docks, which are often associated with shoreline condominiums, are also located along the shoreline, typically in Segment D. Depending on the nature of any marina-associated future projects, permits will need to be obtained from the City, as well as WDFW, Ecology, and/or the Corps. Because of the presence of federally listed fish species in Lake Washington, any proposed projects will be subjected to a higher standard of review intended to minimize potential impacts to listed fish. Impact minimization measures, which have been identified by state and federal agencies, include reducing or eliminating the number of boathouses and solid moorage covers (which are not allowed under current code), minimizing widths of piers and floats, increasing light transmission through any over-water structures, enhancing the shoreline with native vegetation, improving shallow-water habitat, reducing the overall number and size of pier piles, and improving the quality of stormwater runoff. See discussion of impact minimization measures in Section 5.2 for the basis of the state and federal guidance.

3.10.3 Aquatic Invasive Species

Noxious weeds of Washington State are non-native, invasive plants defined by law as a plant that when established is highly destructive, competitive, or difficult to control by cultural or chemical practices (RCW 17.10). These plants have been introduced intentionally and unintentionally by human actions. Most of these species were brought in without any natural enemies, such as insects or diseases, to help keep their populations in check. As a result, these plants can often multiply rapidly (Ecology and Washington State Department of Agriculture 2004). Species of aquatic noxious weeds found throughout Lake Washington are listed in Table 10. The two most common invasive species that are impacting Kirkland's marinas, residential waterfront owners, and wildlife are milfoil and water lily.

Table 10. Aquatic noxious weeds found in Lake Washington - modified from *Aquatic Plants and Fish* (WDFW 1997).

Common Name	Scientific Name	Growth Habitat
Eurasian watermilfoil	*Myriophyllum spicatum*	Submergent
Brazilian elodea	*Egeria densa*	Submergent
Parrot-feather	*Myriophyllum aquaticum*	Submergent
Hydrilla	*Hydrilla verticillata*	Submergent
Fanwort	*Cabomba caroliniana*	Submergent
Fragrant (or white) water lily	*Nymphaea odorata*	Floating mats

Impacts: The introduction of any non-native species has an effect on native species and habitats, although it is often difficult to predict those effects. However, there is a growing number of non-native aquatic plant and animal species whose current or potential impacts on native species, and habitats are known to be significant. Potential threats may be evidenced by the degree of negative impact these species have upon the environment, human health, industry and the economy (WDFW 2001). Potential negative impacts relevant to the Lake Washington environment include:

- loss of biodiversity;
- threaten ESA-listed species such as salmon;
- alterations in nutrient cycling pathways;
- decreased habitat value of infested waters;
- decreased water quality;
- decreased recreational opportunities;
- increased safety concerns for swimmers; and
- decrease in property values.

Control: The Washington Department of Fish and Wildlife has set guidelines for aquatic plant control and removal in the pamphlet *Aquatic Plants and Fish*.[1] This serves as the Hydraulic Project Approval (HPA) for any project that is conducted solely for the removal or control of such aquatic noxious weeds, provided that the project is carried out as described in the pamphlet. Mechanical and physical means of removal and control of aquatic noxious weeds are discussed in the pamphlet (more information can be found on WDFW's website). Mechanical and physical methods of removal discussed in the *Aquatic Plants and Fish* pamphlet include hand pulling, hand tools, bottom barrier, weed roller, mechanical cutters, and harvesters. Some mechanical methods may require an individual HPA. If the project calls for any use of herbicides, additional permits are required through Ecology.

Ecology currently issues coverage for aquatic herbicide use under the National Pollutant Discharge Elimination System (NPDES) permit to qualified applicants. The applicant must be a licensed pesticide applicator (WAC 16-228-1545) in the state of Washington and have an aquatic endorsement (WAC 16-228-1545 3[t]). The applicant must agree to comply with all

[1] [1] The online version of the Aquatic Plants and Fish pamphlet is for informational purposes only and copies of it do not satisfy the requirement to have a copy of the Aquatic Plants and Fish pamphlet on the job site when conducting aquatic plant control operations. An official copy must be obtained from WDFW.

requirements of the permit, including posting public notices, adhering to timing restrictions, complying with the specific application restrictions for each herbicide product, conducting monitoring, performing sampling and analytical procedures, and reporting and recordkeeping (Ecology 2006).

As of 2006, there are seven aquatic herbicides approved for the management of noxious aquatic plants in lakes, rivers, and streams. The characteristics and recommended usage of these herbicides are summarized in Table 11.

Table 11. Aquatic herbicides approved for use in Lake Washington requiring NPDES permit coverage through the Washington Department of Ecology.

Aquatic Herbicide Name	Type of Herbicide	Targeted Species and Recommended Usage
Glyphosate	Systemic broad spectrum, non-selective herbicide	Floating plants, not submerged plants
Fluridone	Broad spectrum, slow-acting systemic herbicide	Eurasian watermilfoil and Brazilian elodea
2,4-Dichlorophenoxyacetic acid, dimethyl-amine salt	Liquid formulation; fast-acting, systemic, selective herbicide	Selective to Eurasian watermilfoil and Brazilian elodea
Endothall - Dipotassium Salt	Fast-acting, non-selective contact herbicide	Short term (one season) control of a variety of aquatic plants
Diquat	Fast-acting, non-selective contact herbicide	Short term (one season) control of a variety of submersed aquatic plants
Triclopyr	Fast-acting, systemic, selective herbicide	Selective to Eurasian watermilfoil
Imazapyr	Systemic broad spectrum, slow-acting herbicide	Floating plants, not submerged plants
All aquatic herbicides may only be used by an approved licensed herbicide applicator (Ecology; http://www.ecy.wa.gov/programs/wq/plants/management/aqua028.html)		

Depending on the herbicide used, it may take several days to weeks or several treatments during a growing season before the herbicide controls or kills treated plants. Rapid-acting herbicides like endothall and diquat may cause low oxygen conditions to develop as plants decompose. Low oxygen can cause fish kills. Additional information about invasive aquatic plants and methods of control can be found in the Water Quality section of Ecology’s website.

There is often a fine line between whether or not control is biologically necessary or justifiable. Depending on the method of control chosen, there could be disturbance of the substrate, reduction in benthic invertebrates (which are an important food source), and increased risk of spread of the invasive species to other areas. Depending on the condition of the sediments, substrate disturbance can result in acute, although temporary, increases in turbidity and may re-introduce pollutants bound to the sediments back into the water column. In addition, reductions in aquatic vegetation, whether native or non-native, reduce primary productivity, which is the foundation of the lake food chain. This could result in reduced fish production at the top of the food chain (Kahler et al. 2000). However, control of invasive aquatic vegetation may be biologically justifiable where the plants are so dense that dissolved oxygen (DO) levels fall to suboptimal or even lethal levels (2-4 mg/L). DO levels drop below dense surface mats because light is blocked to the submerged aquatic vegetation which produces the majority of the oxygen to the water column. Much of the oxygen produced by the surface mats of vegetation is lost to the atmosphere. Decomposition of submerged dead material also depletes the water column of oxygen. In addition, dense vegetation can reduce wave action at the surface, which would otherwise help oxygenate the water. Reduced wave action can also contribute to increased water temperature, as the cooler water from deep areas does not flush the warmer, vegetated shallow areas. Warmer water holds less oxygen than cold water.

City Conditions: Eurasian watermilfoil and water lily are a public and, in some areas, an ecological nuisance in Yarrow and Juanita Bays, as well as in patches along the remainder of the Kirkland shoreline, particularly in some of the marinas and other shallow-water nearshore areas. Where milfoil is dense and close to the surface, it can entangle swimmer's legs and clog boat props. Propeller action can also chop the milfoil into small bits, which disperse in the lake and start new infestations. Nuisance-motivated control of invasive vegetation using herbicides has been approved by Ecology for the Yarrow Shores Condominiums, and the Carillon Point Marina and condominiums through 2011. Mechanical control per the WDFW HPA is likely occurring at numerous other locations.

In Juanita Bay, dense milfoil and water lily has exacerbated a problem with reduced water circulation partially caused by the large, enclosed pier at Juanita Beach Park and the extensive shallow-water created by sediment deposition from Juanita Creek. Reduced circulation has influenced water quality by not allowing pollutants washed into the Bay from the uplands and pollutants carried by Juanita Creek to be flushed by and diluted into the larger lake. Reduced circulation combined with shallow water has also contributed to increases in water temperature. A *Juanita Bay Park Vegetation Management Plan* was prepared in 2004 by Sheldon & Associates Inc. The aquatic portion of Juanita Bay Park is part of the "nearshore management area" in the "western wetland zone." The *Juanita Bay Park Vegetation Management Plan* acknowledges that "shallow shoreline areas with aquatic bed vegetation are the most biologically productive habitats in the lake environment," and concludes that "no actions are warranted in this management area because they would be ecologically damaging, not sustainable, and of limited value to the public" (Sheldon & Associates, Inc. 2004). The City of Kirkland's Parks and Community Services Department concurred with that assessment, so no management of the white water lily is occurring at this time.

Frodge et al. (1995) conducted a study of the effects on fish of reduced DO in densely vegetated areas. One of the study sites was the southeast shore of Juanita Bay, in a patch of white water lily and a patch of milfoil. Complete mortality of the test fish (steelhead trout) occurred in a 12-hour period at a depth of 1 meter under the water lily canopy and in a 24-hour period at a depth of 2 meters under the milfoil canopy. Dissolved oxygen at these depths fell below 4 mg/L. Other effects of low DO are mortality of the insect prey base of salmonids, reduced fish appetite and growth, and avoidance of the low-DO area, which may result in increased predation (Frodge et al. 1995). Based on the results of this study, it would be prudent to re-assess the need for some aquatic vegetation management in Juanita Bay after conducting additional DO studies.

Because of the benefits of aquatic vegetation, complete removal is not recommended. Engel (1988, cited in Frodge et al. 1995) recommends "that harvesting plans incorporate cutting paths through the vegetation to maintain the beneficial aspects of aquatic macrophytes while reducing overall biomass." Frodge et al. (1995) note that "[w]hile the densities of aquatic macrophytes that result in these water quality changes only persist for a short period of the year, these changes may represent an environmental bottleneck to the fish population in lakes with seasonally dense macrophyte growth."

As part of inter-agency coordination with other Lake Washington jurisdictions engaged in the SMP update process, the City of Kirkland has raised the issue of a need for collaboration between all Lake Washington cities and King County on a joint, coordinated strategy for addressing aquatic invasive species around Lake Washington. To date, potential stakeholders who may be able to contribute to the development of a coordinated plan are being identified and contacted.

3.11 OPPORTUNITY AREAS

Ecology's *Shoreline Master Program Guidelines* (173-26 WAC) includes the following definition:

> "Restore," "Restoration" or "ecological restoration" means the reestablishment or upgrading of impaired ecological shoreline processes or functions. This may be accomplished through measures including but not limited to re-vegetation, removal of intrusive shoreline structures and removal or treatment of toxic materials. Restoration does not imply a requirement for returning the shoreline area to aboriginal or pre-European settlement conditions.

Consistent with Ecology's definition, use of the word "restore," or any variations, in this document is not intended to encompass actions that re-establish historic conditions. Instead, it encompasses a suite of strategies that can be approximately delineated into four categories: creation (of a new resource), restoration (of a converted or substantially degraded resource), enhancement (of an existing degraded resource), and protection (of an existing high-quality resource).

There is a critical distinction between restoration and mitigation. Mitigation will require applicants whose shoreline proposals will have adverse impacts to complete actions to mitigate those impacts or provide compensation in other ways for losses of ecological function. The City cannot require applicants to go beyond returning the impacted area (or compensating in other ways for lost functions) to the condition it was in at the time of this inventory or as further detailed at the time of application. However, the City can encourage applicants to implement restoration actions that will improve ecological functions relative to the applicant's pre-project condition. As stated in WAC 173-26-201(2)(c):

> It is intended that local government, through the master program, along with other regulatory and nonregulatory programs, contribute to restoration by planning for and fostering restoration and that such restoration occur through a combination of public and private programs and actions. Local government should identify

> restoration opportunities through the shoreline inventory process and authorize, coordinate and facilitate appropriate publicly and privately initiated restoration projects within their master programs. The goal of this effort is master programs which include planning elements that, when implemented, serve to improve the overall condition of habitat and resources within the shoreline area of each city and county."

The Opportunity Areas discussions in this section and in Chapter 4 present options for "restoration" that would improve ecological functions (Figure 15). For example, enhancement of riparian vegetation, reductions or modifications to shoreline hardening, minimization of in- and over-water structures, and improvements to fish passage would each increase one or more ecological parameters of the City's shoreline. These options could be implemented voluntarily by the City or City residents or, depending on specific project details, could be required measures to mitigate adverse impacts of new shoreline projects. The *Salmon and Steelhead Habitat Limiting Factors Report for the Cedar-Sammamish Basin (Water Resource Inventory Area 8)* (Kerwin 2001) identifies the following five "limiting habitat factors and impacts on Lake Washington:"

- The riparian shoreline of Lake Washington is highly altered from its historic state. Current and future land use practices all but eliminate the possibility of the shoreline to function as a natural shoreline to benefit salmonids;
- Introduced plant and animal species have altered trophic interactions between native animal species;
- The known historic practices and discharges into Lake Washington have contributed to the contamination of bottom sediments at specific locations;
- The presence of extensive numbers of docks, piers and bulkheads have highly altered the shoreline; and
- Riparian habitats are generally non-functional.

Opportunity areas were initially identified during the compilation of the critical areas materials described above, review of 2005 aerial photographs, and a field reconnaissance in March 2006. More detailed descriptions of each segment can be found in Section 4.0 below. Generally, restoration opportunities which have been identified are focused on City property, including parks, open spaces, and street-ends. Many other restoration opportunities exist throughout the City on private property. These opportunities would include many of the same issues as listed above, but would likely occur only through voluntary means or through re-development proposals.

A second category of restoration opportunities that will be discussed in greater detail in a separate Shoreline Restoration Plan document are those planned for implementation as part of the City's *2006-2011 Capital Improvement Program* report. Of particular relevance to the objective of improving shoreline function are the Parks and Surface Water Management Utility elements. These elements include numerous projects that provide wetland enhancement, fish passage improvement, bioengineered streambank stabilization, restoration of armored streambanks, flood abatement, water quality improvement, and riparian vegetation enhancement among others. Many of these projects are planned "upstream" of shoreline jurisdiction, but will still have positive affects on the shoreline environment.

The 2005 *Final Lake Washington/Cedar/Sammamish Watershed (WRIA 8) Chinook Salmon Conservation Plan* does not identify any specific projects along the Kirkland shoreline or in nearby areas up- and down-lake, but does include the following general recommendations to reduce predation on outmigrating juvenile chinook salmon in its “Action Start-List for Migratory Areas”:

- Encourage salmon friendly shoreline design during new construction or redevelopment by offering incentives and regulatory flexibility to improve bulkhead and dock design and revegetate shorelines. Increase enforcement and address nonconforming structures over long run by requiring that major redevelopment projects meet current standards.
- Discourage construction of new bulkheads; offer incentives (e.g., provide expertise, expedite permitting) for voluntary removal of bulkheads, beach improvement, riparian revegetation.
- Support joint effort by NOAA Fisheries and other agencies to develop dock/pier specifications to streamline federal/state/local permitting; encourage similar effort for bulkhead specifications.
- Promote value of light-permeable docks, smaller piling sizes, and community docks to both salmon and landowners through direct mailings to lakeshore landowners or registered boat owners sent with property tax notice or boat registration tab renewal. Offer financial incentives for community docks in terms of reduced permit fees, loan fees/percentage rates, taxes, and permitting time, in addition to construction cost savings.
- Develop workshop series specifically for lakeshore property owners on lakeside living: natural yard care, alternatives to vertical wall bulkheads, fish friendly dock design, best management practices for aquatic weed control, porous paving, and environmentally friendly methods of maintaining boats, docks, and decks. Related efforts include creation of a website to convey workshop material, an awareness campaign, “Build a Beach,” to illuminate impact of bulkheads on development of sandy beaches.
- Restore shoreline in Lake Washington Section 1: work with private property owners to restore shoreline in Section 1. Use interpretive signage where possible to explain restoration efforts.

Additional recommendations to further water quality restoration of the lake and its tributaries, reduce the population of cutthroat trout,[1] and enhance juvenile chinook rearing areas are as follows:

- Address water quality and high flow impacts from creeks and shoreline development through NPDES Phase 1 and Phase 2 permit updates, consistent with Washington Department of Ecology’s 2001 *Stormwater Management Manual*, including low impact development techniques, on-site stormwater detention for new and redeveloped projects, and control of point sources that discharge directly into the lakes. Stormwater impacts from major transportation projects (for new and expanded roadways proposed during the next ten years) should be addressed. Encourage low impact development through regulations, incentives, education/training, and demonstration projects throughout subarea.

[1] Cutthroat trout are currently considered the dominant predator in Lake Washington. See section 5.2.3 for more information on predator-prey interactions in Lake Washington.

- Protect and restore water quality and other ecological functions in tributaries to reduce effects of urbanization and reduce conditions which encourage cutthroat. Protect and restore forest cover, riparian buffers, wetlands, and creek mouths by revising and enforcing critical areas ordinances and Shoreline Master Programs, incentives, and flexible development tools.
- Promote through design competitions and media coverage the use of “rain gardens” and other low impact development practices that mimic natural hydrology. Combine a home/garden tour or “Street of Dreams” type event featuring these landscape /engineering treatments.

A Restoration Plan document will be prepared in 2007 as a later phase of the Shoreline Master Program update process, consistent with WAC 173-26-201(2)(f). The Restoration Plan will “include goals, policies and actions for restoration of impaired shoreline ecological functions. These master program provisions should be designed to achieve overall improvements in shoreline ecological functions over time, when compared to the status upon adoption of the master program.” The Restoration Plan will mesh the specific potential projects identified in this report, with regional or City-wide efforts and programs of the City, watershed groups, and environmental organizations that contribute or could potentially contribute to improved ecological functions of the shoreline. Prioritization of specific projects and project types will be based on a quantitative assessment where feasible, and implementation strategies and schedule will be outlined.

4.0 CONDITIONS BY INVENTORY SEGMENT

To categorize distinct segments of the City’s shorelines for planning purposes, the shoreline jurisdiction was classified into four segments (A through D) (see Table 2 above) based broadly on the level of ecological functions provided by each segment, as well as existing land uses and zoning. For each shoreline planning segment, a summary discussion is followed by a discussion of specific elements of the shoreline inventory for those elements that are not covered in sufficient detail in Section 3 above. Detailed maps are included in the Map Folio, Appendix E.

4.1 SEGMENT A: POTENTIAL ANNEXATION AREA

Segment A encompasses the entire PAA, which extends from just south of St. Edwards State Park to the west edge of Juanita Beach Park.

4.1.1 Land Use Patterns

Segment A is designated in the King County Comprehensive Plan as entirely residential, primarily four to eight units per acre. Within the PAA, it is estimated that there are 335 dwelling units. Table 12 identifies the percentage of the segment that is covered by each zone. O.O. Denny Park, approximately 6 percent of this segment, is the only other existing land use. In the shoreline zone, the park includes areas of gravelly beach suitable for kayak launching, swimming, mowed picnic and other groomed areas, and wooded areas. Due to its access to Lake Washington, the park is considered to be a water enjoyment facility. Table 12 also identifies the shoreline environment designation in this segment, which is currently regulated by King County.

Table 12. Segment A Land Use, Comprehensive Plan Designation, and Shoreline Environment Designation

<table>
<tr><th>Existing Land Use</th><th colspan="2">Comprehensive Plan Designation (King County)</th><th>Previous Shoreline Environment Designation (King County)</th></tr>
<tr><td rowspan="2">• Single-family residences
• O.O. Denny Park</td><td>Urban residential, high (>12 du/acre)</td><td>1.1 acres / 1%</td><td rowspan="2">Urban</td></tr>
<tr><td>Urban residential, medium (4-12 du/acre)</td><td>87.3 acres / 99%</td></tr>
</table>

Source: City of Kirkland GIS

4.1.2 Shoreline Modifications

As noted above in Tables 7 and 8, the shoreline of Segment A is heavily modified with 76 percent of the shoreline armored at or near the ordinary high water mark, overwater coverage of 8.9 square feet per linear foot of shoreline, and an overwater structure density of approximately 54.9 per mile. Many of the piers have one or more boatlifts, and approximately 25 percent of the boatlifts have canopies. It is not uncommon around Lake Washington for some historic fills to be associated with the original bulkhead construction, usually to create a more level or larger yard. Most of these shoreline fills occurred at the time that the lake elevation was lowered during construction of the Hiram Chittenden Locks. No attempt was made during the field investigation to assess the extent of shoreline fills. The impacts of pier and bulkhead modification on ecological functions are described in detail in Section 5.0.

4.1.3 Critical Areas

Streams. Streams within Segment A are typically steep hillside drainages that flow directly to Lake Washington. While none of these streams are known to support large populations of anadromous fish, their drainages are generally well protected from the effects of urbanization, having several large blocks of relatively undisturbed open space habitat. The largest of these streams, Denny Creek, has been documented to support coho salmon and cutthroat trout in the lower section downstream and just upstream from Holmes Point Drive (The Watershed Company 1998; King County DNR 2001). In addition to Denny Creek, cutthroat trout have been documented in Champagne Creek and an unnamed drainage (Stream 0227) just north of Denny Creek. Denny Creek flows through a deep ravine within a well-vegetated corridor located almost entirely within parks or designated urban natural open space. The mouth of Denny Creek flows through O.O. Denny Park before discharging into Lake Washington. The lower section of Denny Creek near Holmes Point Drive, as well as upstream sections up to Juanita Drive, may present opportunities for habitat restoration and improvements to fish migration.

Wetlands. No wetlands are mapped in this King County segment by any of the reviewed sources (WDFW 2006; King County iMap), nor have hydric soils been mapped in this segment by the NRCS. However, it is possible that unmapped wetlands are present along the Denny Creek stream corridor or at the mouth of Denny Creek.

Fish and Wildlife Habitat. The majority of Segment A does not contain any significant fish or wildlife habitats other than Lake Washington and the streams described above. Residential development close to the shoreline, with accompanying landscaping and shoreline modifications, has removed much of the potential riparian habitat. The Denny Creek corridor within O.O. Denny Park, however, is a priority habitat and contains two priority species (Figure 13). "Urban natural open space" is designated when "[a] priority species resides within or is adjacent to the open space and uses it for breeding and/or regular feeding; and/or the open space functions as a corridor connecting other *priority habitats*, especially those that would otherwise be isolated; and/or the open space is an isolated remnant of natural habitat larger than 4 ha (10 acres) and is surrounded by urban development" (http://wdfw.wa.gov/hab/phshabs.htm).

The two priority species mapped in the Denny Creek corridor are the bald eagle (listed as state and federally threatened) and the pileated woodpecker (state candidate). Although the bald eagle nests (multiple sites used by single pair between 1998 and 2005) are outside of shoreline jurisdiction (Figure 13), these eagles are foraging in adjacent Lake Washington and are perching in large trees located in the shoreline zone. O.O. Denny Park has been noted as having excellent forest habitat, which provides nesting and foraging opportunities for the pileated woodpecker. WDFW (2006) has reported observations of the pileated woodpecker year-round. Numerous other wildlife species are also likely utilizing O.O. Denny Park and the Denny Creek corridor.

4.1.4 Opportunity Areas

<u>O.O. Denny Park (*Fish Habitat*)</u>: Reduce shoreline armoring and improve nearshore native vegetative cover. Remnants of a small concrete bulkhead exist along the north end of the park. This bulkhead has shown significant failure and no longer functions as intended. Invasive vegetation, primarily Himalayan blackberry, also lines most of this shoreline area. A combination of native revegetation and bioengineering techniques could be provided to secure the bank from excessive erosion. Bioengineering techniques could also be utilized to modify the existing wooden bulkhead that fronts the majority of the park. Although this bulkhead is functioning as intended, it lacks habitat complexity and may exacerbate erosion due to the vertical face. In general, most of the park shoreline has the potential for additional native vegetation which would add habitat complexity and contribute to large woody debris recruitment in the future.

<u>General</u>: Many residential shoreline properties throughout the PAA have the potential for improvement of ecological functions through: 1) reduction or modification of shoreline armoring, 2) reduction of overwater cover and in-water structures (grated pier decking, pier size reduction, pile size and quantity reduction, moorage cover removal), 3) improvements to nearshore native vegetative cover, and/or 4) reductions in impervious surface coverage. Similar opportunities would also apply to undeveloped lots which may be used as community lots for upland properties or local street-ends and utility corridors. Other opportunities may exist to improve either fish habitat or fish passage for those properties which have streams discharging to Lake Washington.

See Section 3.11 for discussion of how identified Opportunity Areas within each segment fit into the larger restoration strategy.

4.2 SEGMENT B: JUANITA BAY AND YARROW BAY

The north portion of Segment B extends east and south from the west edge of Juanita Beach Park to the southwest edge of Juanita Bay Park. The south portion of Segment B consists of the Yarrow Bay wetlands.

4.2.1 Land Use Patterns

Segment B has a mix of land uses and comprehensive plan designations, including commercial, office, several categories of residential, and parks. However, as noted in Table 13, the majority of the segment is park/open space (Juanita Beach Park, Juanita Bay Park and Yarrow Bay Wetlands). Actual impervious surfaces within the segment are very low (only 3% within the segment) (see Table 6), which supports the aerial photograph interpretation that most structures and development associated with those designations are primarily located outside of shoreline jurisdiction. Development that is within shoreline jurisdiction includes single-family residences in the southern portion of the segment along the Forbes Creek corridor, a couple of condominium complexes, a retail craft store, as well as a restaurant and office complex adjacent to Juanita Bay. Table 13 also identifies the shoreline environment designations in this segment.

Because most of the area is either already developed or designated park or open space, the potential for redevelopment is very limited. As Table 4 indicated, there are currently 168 dwelling units in Segment B (165 multi-family and 3 single-family). Based on current zoning, it is estimated that this area has the capacity for an additional 48 multi-family units and 25 single-family units.

For non-residential uses, Segment B is estimated to have approximately 49,300 square feet of retail and 443,300 square feet of office (see Table 5 above). Retail use and office use are located in the Juanita Bay area. The capacity for additional retail is estimated to be 7,600 square feet and for office it is estimated to be an additional 13,400 square feet.

The only potential inconsistencies identified between planned land use and appropriate land use in the City of Kirkland's shoreline zone are in Segment B. West of and contiguous with the Yarrow Bay Wetlands adjacent to the City limits, are a number of properties zoned "low density residential" that are currently undeveloped and forested. These properties are mapped as wetland, floodplain, medium landslide hazard area, seismic hazard area, hydric soils, and/or are protected critical area buffers, and as such are likely undevelopable unless a shoreline variance is obtained. On a smaller scale, a few properties along the Forbes Creek corridor and Juanita Bay may be similarly encumbered.

Table 13. Segment B Land Use, Comprehensive Plan Designation, and Shoreline Environment Designation

Existing Land Use	Comprehensive Plan Designation		Previous Shoreline Environment Designation
• Mostly active and natural park/wetland areas. • A few condominiums. • A very small amount of mixed use	Commercial	3.7 acres / 3%	Urban Residential 1 Urban Mixed 1
	Low Density Residential	8.8 acres / 6%	
	Medium Density Residential	4.1 aces / 3%	
	High Density Residential	1.5 acres / 1%	
	Office	0.6 acres / 0%	
	Office/Multi-Family	0.7 acres / 1%	
	Park/Open Space	120.3 acres / 86%	Conservancy 1

Source: City of Kirkland GIS

4.2.2 Shoreline Modifications

As noted above in Table 7, the shoreline of Segment B is the least modified with 93 percent of the shoreline in a natural/semi-natural state (e.g., not armored at or near ordinary high water). There are no single-family residential piers; however, there is a community pier for a condominium, a substantial pier and numerous abandoned piles associated with Juanita Beach Park and Juanita Bay Park, and a large overwater trail/trestle over Juanita Bay near the mouth of Forbes Creek (see Table 8). Segment B has an overwater coverage of 1.5 square feet per linear foot of shoreline, and an overwater structure density of approximately 2.0 per mile. A raised boardwalk, including some interpretive lookouts, is also located along the shoreline of Juanita Bay Park.

4.2.3 Critical Areas

Streams. Segment B contains the three most prominent streams within the City of Kirkland. Juanita Creek, Forbes Creek, and Yarrow Creek are each known to support anadromous fish, including one or more of the following: chinook (juvenile use of the mouths of several streams), coho, and sockeye salmon, steelhead and cutthroat trout (King County DNR 2001; WDFW 2006). All of these species have been documented within Juanita Creek (King County DNR 2001). The Juanita Creek basin is the City's largest drainage basin, encompassing much of the City's north end and PAA. While the riparian corridor of Juanita Creek is much less protected via designated open space than Yarrow or Forbes Creeks, cutthroat trout and coho salmon are believed to inhabit much of the stream corridor up to Interstate 405 (The Watershed Company 1998). Juanita Creek is on Washington's 303(d) list for three Category 5[1] parameters (dissolved oxygen, fecal coliform, and temperature) and two Category 2[2] parameters (mercury, pH). The high fecal coliform loading in the creek and conditions in Juanita Bay have resulted in numerous closures of the swimming beach at Juanita Beach Park. According to King County data, the Bays themselves have seasonal, dangerously high water temperatures.

[1] Category 5 parameters require the development of Total Maximum Daily Load (TMDL) plans that establish target discharge amounts for various point sources and best management practices for nonpoint sources of the Category 5 pollutant. The goal of a TMDL is to reduce the pollutant load so that the water quality standard is met.

[2] Category 2 parameters are "waters of concern;" they are not considered "impaired," but they warrant continued monitoring.

The Yarrow and Forbes Creek systems, while more protected near their mouths, have slightly steeper stream gradient and lower year-round flow, which minimizes the extent of fish access, primarily salmonids. Coho salmon have been observed in Forbes Creek as far upstream as 108th Avenue, but could potentially reach farther upstream just beyond the culvert under Forbes Creek Drive. Yarrow Creek lies partially within the Cities of Kirkland and Bellevue, with both the mouth (Yarrow Bay Wetlands) and headwaters (Bridle Trails State Park) occurring within Kirkland. While fish are present throughout much of Yarrow Creek, several migration barriers, most notably at the railroad grade, likely block migration, effectively creating isolated populations. Both Forbes and Yarrow Creeks are on the Category 5 303(d) list for dissolved oxygen and fecal coliform. In addition, Forbes Creek is listed as Category 5 for temperature and as Category 2 for mercury. Additional information about habitat conditions in Juanita Creek can be found in the City of Kirkland and King County's jointly conducted comprehensive habitat inventory and assessment (ftp://dnr.metrokc.gov/dnr/library/2002/kcr934.pdf). The impact of sediment inputs from Juanita Creek into Juanita Bay is discussed in Section 4.2.4 below.

Wetlands. The majority of Segment B has been mapped by the City of Kirkland as wetland (Figure 11). These wetlands have been identified and described in *Kirkland's Streams, Wetlands and Wildlife Study* (The Watershed Company 1998). Each of these wetlands is characterized briefly in Table 14.

Table 14. Segment B Wetlands.

Wetland Name	Approximate Total Size	Cowardin Wetland Classes	Dominant Vegetation	Notes
Forbes 1	82.65 acres	Palustrine forested, scrub-shrub, emergent, open water, aquatic bed	Red alder, willow, cottonwood, salmonberry, spiraea, red-osier dogwood, skunk cabbage, buttercup, small-fruited bulrush, lady fern, soft rush, reed canarygrass, horsetail, cattail, purple loosestrife	Rated "high quality" for all functions (e.g., habitat, flood storage, baseflow/ groundwater support, shoreline protection, cultural/recreational, and water quality functions).
Forbes 2	1.28 acres	Palustrine forested, emergent	Red alder, cottonwood, spiraea, Himalayan blackberry, reed canarygrass	Rated low to moderate quality for all functions, separated from Forbes 1 by 98th Avenue NE.
Yarrow 1	73.6 acres	Palustrine forested, scrub-shrub, emergent, open water, and lacustrine aquatic bed	Red alder, willow, cottonwood, salmonberry, spiraea, red-osier dogwood, Himalayan blackberry, reed canarygrass, cattail	Rated "high quality" for all functions

Source: The Watershed Company 1998

The Forbes 1 and Yarrow 1 wetlands are also mapped as priority wetlands by WDFW (2006). Priority wetlands are those that wetlands that have "[c]omparatively high fish and wildlife density, high fish and wildlife species diversity, important fish and wildlife breeding habitat, important fish and wildlife seasonal ranges, limited availability, [and] high vulnerability to habitat alteration" (http://wdfw.wa.gov/hab/phshabs.htm). Figures 14a and 14b include delineation of palustrine forest, scrub-shrub, and emergent wetland vegetation classes based on aerial photograph interpretation.

Fish and Wildlife Habitat. Both the Yarrow Bay Wetlands and Juanita Bay Park extending up the Forbes Creek corridor provide excellent habitat for birds (songbirds, raptors, waterfowl), amphibians, mammals and even reptiles. According to the Winter 2005 edition of the Juanita Bay newsletter (City of Kirkland 2005b), 167 species have been observed in Juanita Bay Park.

As previously mentioned, both Forbes 1 and Yarrow 1 (the Yarrow Bay Wetlands) are designated as priority wetlands by WDFW (2006). In addition, the Forbes Creek corridor is designated by WDFW as a priority "riparian zone" because it has been determined to meet these criteria: "[h]igh fish and wildlife density, high fish and wildlife species diversity, important fish and wildlife breeding habitat, important wildlife seasonal ranges, important fish and wildlife movement corridors, high vulnerability to habitat alteration, unique or dependent species" (http://wdfw.wa.gov/hab/phshabs.htm). Bald eagles and ospreys regularly perch in trees adjacent to Juanita and Yarrow Bays, and forage in the Bays. Pileated woodpeckers (a State Candidate species) also reportedly nest in the Juanita Bay wetlands, and according to the East Lake Washington Audubon Society, purple martins (a State Candidate species) used nesting gourds installed in early 2006 around the Bay (Sollitto, pers. comm., 18 August 2006). Although a bald eagle nest is mapped in the Yarrow Bay Wetlands, it was last active in 1999 and the nesting pair relocated to Hunts Point. However, the mapped great blue heron nesting colony is still active. According to a local kayaker report to the Kirkland Parks and Community Services Department, at least three heron nests were observed in Yarrow Bay Wetlands in 2006.

4.2.4 Area of Special Interest – Juanita Bay Sedimentation

Since the City obtained ownership of Juanita Beach Park in 2002, it has prepared the *Juanita Beach Park Master Plan* (J.A. Brennan and Associates, PLLC 2006) that addresses existing and potential future conditions of the built and natural elements of the Park. The issue of sedimentation of Juanita Bay has implications for the human enjoyment of the park, public safety, and wildlife habitat, and so is discussed at some length. In summary, the north and east ends of the Bay have historically been very shallow with sandy beaches, and Juanita Creek has historically contributed a large amount of sand into the Bay. This is a natural process in this watershed, where soils are predominantly sandy glacial outwash material. However, it is acknowledged that sediment inputs from the creek have increased as a result of urbanization and past inadequate erosion controls. It is probable that sediment inputs as a result of poor erosion control in the basin have declined with the advent and implementation of better erosion control practices and regulation. However, changes to Juanita Creek hydrology are likely still resulting in increased sedimentation of the Bay as a result of increased peak flows eroding the banks and the loss of riparian wetlands to help moderate the flows and store sediments.

Sediment accumulations in the Bay, including a delta that is functioning somewhat like a berm between the creek outfall and the Juanita Beach Park pier, have restricted the natural flow of water through the Bay clockwise from the northwest. Skirting along the outside of the pier surrounding the swimming area has also affected the location of sediment accumulation and interfered with water flow. Accordingly, pollutant inputs from Juanita Creek, including fecal coliform, may move east towards and into the swimming area, but then remain there. The combined affect of reduced water depth and water flows, along with a probable accompanying increase of aquatic vegetation that can colonize the shallow substrates, also results in increased water temperatures, which are detrimental to fish.

The *Juanita Beach Park Master Plan* (J.A. Brennan and Associates, PLLC 2006) suggests several possible remedies, including:

- "dredge the delta to a depth of 3-5 feet;
- dredge up fine sediment at the beach;
- implement maintenance dredging at delta to remove sediment every few years;
- remove the planking on the piers to allow natural sediment movement in the bay;
- implement sediment detention and removal in the creek basin to reduce sediment load into the lake; [and]
- reduce sources of sediment into the basin."

Successful management of the sedimentation problem will require implementation of several of the remedies. However, the potential short-term effects of the various in-lake sediment removal options need to be evaluated before action is taken. Funding is not yet available to implement the first four elements of the *Juanita Beach Park Master Plan*. The City of Kirkland has several projects planned for 2007 in its Capital Improvement Program that address the last two bullets. For example, a sediment pond will be constructed in Juanita Creek, and several areas of eroding streambank in Juanita Creek and its tributaries will be stabilized with native vegetation. In addition, a major Juanita Creek enhancement project will be implemented in Juanita Beach Park. According to the project description in the City's CIP report, "[e]fforts will be directed to reduce flooding, sedimentation, and channel migration/incision. Proposed riparian/channel enhancements would provide aquatic, terrestrial and avian habitat as well as aesthetically pleasing community green/open space" (City of Kirkland 2006). In the long term, additional in-line detention ponds will be constructed along Juanita Creek to "provide for detention, sediment control and flood prevention in connection with both public construction and private development activities" (City of Kirkland 2006).

4.2.5 Opportunity Areas

Juanita Beach Park (Fish Habitat/Migration): The large overwater boardwalk with skirting**,** which forms the designated swimming area, has the potential for impact reduction by installing deck grating in the pier decking and potentially removing or redesigning the breakwater in order to improve migratory conditions for juvenile salmonids and water circulation (see 4.2.4 above). Potential in-stream habitat improvements exist at the mouth of Juanita Creek (delta), including large woody debris installation and improvements to native vegetative cover (see 4.2.4 above). The *Final Lake Washington/Cedar/Sammamish Watershed (WRIA 8) Chinook Salmon Conservation Plan* (WRIA 8 Steering Committee 2005) includes potential restoration of the mouth of Juanita Creek through the removal of bank armoring and returning the mouth to a more natural outlet as Project C296 on the "Lake Washington - Tier I - Initial Habitat Project List." It is identified as a low-priority project, however, because of its limited benefit to chinook salmon and perceived low feasibility.

Forbes Creek/Juanita Bay Park (Invasive Vegetation): Invasive vegetation, primarily reed canarygrass, purple and garden loosestrife, and Himalayan blackberry in the terrestrial zones and white water lily in the aquatic zone, is currently growing throughout the Forbes Creek riparian corridor and Juanita Bay Park. Efforts to control invasive vegetation, including eradication and replanting with native vegetation, have occurred in the past. The *Juanita Bay Park Vegetation Management Plan* was prepared in 2004 by Sheldon & Associates Inc. It divides the park into 10 management areas by habitat type that are distributed among three landscape zones based on location and historic use. Goals and objectives were established for each landscape zone, and then treatments are suggested for each management area within the landscape zones. The primary objective for the less developed landscape zones is removal of invasive species and replacement with native species, as well as supplementation of existing native vegetation to increase species and habitat diversity.

As of 31 October 2006, the Kirkland Parks and Community Services Department has devoted 1,101 hours of staff time in 2006 to activities that implement the *Juanita Bay Park Vegetation Management Plan*, plus an addition 49 hours working with volunteer groups at Juanita Bay Park (Filan, pers. comm., 14 November 2006). One of the volunteer groups, TASK (Teens Assisting Sustainable Kirkland), spent 513 hours removing Himalayan blackberry and English ivy from the Park. Control efforts of purple and garden loosestrife, which are required to be controlled by the King County Noxious Weed Control Board, have included introduction of loosestrife-eating beetles and applications of glyphosate (Filan, pers. comm., 14 November 2006).

See Section 3.10.3 for discussion of aquatic invasive species in Juanita Bay.

Forbes Creek/Juanita Bay Park (Fish Passage/Habitat): Potential improvements to fish passage, especially upstream of 108th Avenue (documented extent of coho salmon), could restore access to additional habitat. Improve fish passage and habitat where possible. Recent studies regarding shading impacts from overwater structures (see Section 5.2) indicate that significant improvements to light availability beneath pier and dock structures can be accomplished through the installation of deck grating (Gayaldo and Nelson 2006). The pedestrian trail/trestle across Juanita Bay to the west of 98th Street covers the mouth of Forbes Creek, potentially inhibiting salmon migration. The surface of the walkway could be re-decked with a grated material to reduce shading impacts to the aquatic environment. Many remnant pier piles located within Juanita Bay could be removed.

Yarrow Bay (Invasive Vegetation): In conjunction with possible aquatic invasives species control in Juanita Bay, the biological need for control of aquatic invasive species in Yarrow Bay should be assessed by conducting dissolved oxygen studies. Both Yarrow Shores Condominiums and the Carillon Point Marina and condominiums have permits from Ecology to use chemical controls on milfoil and white water lily, which have become a nuisance to boaters and swimmers.

See Section 3.11 for discussion of how identified Opportunity Areas within each segment fit into the larger restoration strategy.

4.3 SEGMENT C: RESIDENTIAL

Segment C extends south from the southwest edge of Juanita Bay Park to the north edge of Marina Park.

4.3.1 Land Use Patterns

Segment C is very similar to Segment A in its dominant character of single-family residential, with a smaller component of park/open space (Table 15). The parks include Kiwanis Park, Waverly Beach Park, and Heritage Park/Lake Avenue West Street End Park. Kiwanis Park is the least developed of the three parks, containing woods and an unarmored shoreline. Waverly Beach Park is the most developed, and includes a swimming beach, large pier, and picnic and parking facilities. All parks are considered to be water enjoyment facilities, although since Kiwanis Park is undeveloped, access to Lake Washington is limited. Table 15 also identifies the shoreline environment designations in this segment.

Table 15. Segment C Land Use, Comprehensive Plan Designation, and Shoreline Environment Designation

Existing Land Use	Comprehensive Plan Designation		Previous Shoreline Environment Designation
• Single-family residences • Parks	Low Density Residential	29.5 acres / 73%	Suburban Residential
	Park/Open Space	10.0 acres / 24%	
	Medium Density Residential	1.3 acres / 3%	Urban Residential 1

Source: City of Kirkland GIS

Since it is primarily single-family residential, Segment C has very little capacity for future development. Within this area, capacity is estimated at 13 additional single-family units and no additional multi-family units. Expansion, redevelopment or alteration to existing single-family units will occur over time. Since single-family residences are considered to be a preferred use along the shoreline, very few conflicts are anticipated. However, with remodeling or replacement, opportunities exist to reduce conflicts by improving the shoreline environment.

4.3.2 Shoreline Modifications

As noted above in Tables 7 and 8, the shoreline of Segment C is heavily modified with 83 percent of the shoreline armored at or near the ordinary high water mark, an overwater coverage of 9.0 square feet per linear foot of shoreline, and an overwater structure density of approximately 52.4 per mile. Boatlift canopies within Segment C cover fewer boatlifts (approximately 17%) than those within Segment A. However, while canopies are not allowed in the City's shoreline zone, they are allowed in King County. It is not uncommon around Lake Washington for some historic fills to be associated with the original bulkhead construction, usually to create a more level or larger yard. Most of these shoreline fills occurred at the time that the lake elevation was lowered during construction of the Hiram Chittenden Locks. No attempt was made during the field investigation to assess the extent of shoreline fills. The impacts of pier and bulkhead modification on ecological functions are described in detail in Section 5.0.

4.3.3 Critical Areas

Streams. While there are several storm drainages that collect surface water and discharge directly to Lake Washington within Segment C, no streams have been inventoried within the shoreline jurisdiction of this segment.

Wetlands. No wetlands are mapped in this King County segment by any of the reviewed sources (WDFW 2006, King County iMap), nor have hydric soils been mapped in this segment by the NRCS.

Fish and Wildlife Habitat. Segment C does not contain any significant fish or wildlife habitats other than Lake Washington. Residential development close to the shoreline, with accompanying landscaping and shoreline modifications, has removed much of the potential riparian habitat. A bald eagle nest site is mapped just outside of shoreline jurisdiction (WDFW 2006); however, these eagles are foraging in adjacent Lake Washington and are perching in large trees located in the shoreline zone.

4.3.4 Opportunity Areas

<u>Lake Avenue West Street End Park (Native Vegetation)</u>: This small street-end park consists of primarily lawn area with a moderate amount of shoreline vegetation (trees and shrubs). An abundance of invasive vegetation (ivy/reed canarygrass) could be removed and replaced with additional native vegetation to improve shoreline conditions for juvenile salmonids by providing overhanging vegetation for shade, overhead and in-water cover, and allocthonous input of detritus and insects. An old remnant moorage slip located near the south property line that is not connected to shore could be removed to reduce in- and overwater structures.

<u>Waverly Beach Park (Fish Habitat)</u>: Several opportunities exist to improve habitat conditions along the shoreline. These include: reduction of overwater cover by the existing pier through the installation of deck grating, removing pier skirting as feasible, removing or minimizing the impacts of shoreline armoring; and supplementation of nearshore native vegetation to improve habitat conditions for juvenile salmonids. The impact of existing impervious surfaces (paved parking areas) could be reduced through the use of pervious materials, relocation, or minimization.

<u>General</u>: Many residential shoreline properties throughout Segment C have the potential for improvement of ecological functions through: 1) reduction or modification of shoreline armoring, 2) reduction of overwater cover and in-water structures (grated pier decking, pier size reduction, pile size and quantity reduction, moorage cover removal), 3) improvements to nearshore native vegetative cover, and/or 4) reductions in impervious surface coverage.

See Section 3.11 for discussion of how identified Opportunity Areas within each segment fits into the larger restoration strategy.

4.4 SEGMENT D: URBAN

Segment D extends south from the north edge of Marina Park south to the northeast edge of the Yarrow Bay Wetlands.

4.4.1 Land Use Patterns

Slightly more than half of Segment D is occupied by residential uses, including single-family residences, condominiums and apartment complexes (Table 16). The remainder of the segment is a mix of commercial (downtown Kirkland and Carillon Point restaurants and retail shops), park/open space (six separate parks), and a small area of office/multi-family. As indicated by the high percent imperviousness (55%, Table 3) and aerial photograph interpretation, this segment is the most highly developed relative to the previously analyzed segments. Table 16 also identifies the shoreline environment designations in this segment.

Table 16. Segment D Land Use, Comprehensive Plan Designation, and Shoreline Environment Designation

<table>
<tr><th>Existing Land Use</th><th colspan="2">Comprehensive Plan Designation</th><th>Previous Shoreline Environment Designation</th></tr>
<tr><td rowspan="6">• Single- and multi-family residences
• Parks
• Restaurants
• Retail shops
• Hotel
• Offices</td><td>Commercial</td><td>15.3 acres / 29%</td><td rowspan="2">Urban Residential 1 and Urban Mixed 1</td></tr>
<tr><td>Park/Open Space</td><td>9.4 acres / 18%</td></tr>
<tr><td>Low Density Residential</td><td>1.0 acre / 2%</td><td>Urban Residential 2</td></tr>
<tr><td>Medium Density Residential</td><td>25.2 acres / 47%</td><td>Urban Residential 1 & 2</td></tr>
<tr><td>High Density Residential</td><td>2.2 acres / 4%</td><td rowspan="2">Urban Residential 1</td></tr>
<tr><td>Office / Multi-Family</td><td>0.4 acre / 1%</td></tr>
</table>

Source: City of Kirkland GIS

Segment D is the highly urbanized section of the shoreline area with the largest number of residential units (1,251) and non-residential space (1,095,500 ft^2 of retail and office). Several parcels have single-family dwelling units, which will probably convert over time to multifamily. It has the capacity to add 401 multi-family units (with no additional capacity for single-family), as well as 50,600 square feet of retail space and 82,500 square feet of office. Non-residential development is likely to occur either in the downtown area or on scattered commercial properties on the east side of Lake Washington Boulevard. This area also contains several over-water structures (multi-family condominiums), which are no longer allowed.

This segment also contains the City's four marinas, which, by definition, are water-dependent. Three are commercial marinas (Carillon Point, Yarrow Bay Marina, Kirkland Yacht Club) and one is a public marina in downtown Kirkland at Marina Park. The Yarrow Bay Marina, which has 115 slips, has received approval to construct an office building east of the marina adjacent to Lake Washington Boulevard. The project includes public access to the waterfront along with an area reserved for a public view corridor. At Marina Park's Kirkland Public Dock, there are 77 temporary slips available for public use along with the tour dock. South of the public piers and slips is the Kirkland Yacht Club with 101 slips. Seven slips are available for public use and 21 slips are open to the public by reservation for long-term moorage. Carillon Point Marina has approximately 185 slips and is part of a large mixed-use office, retail, restaurant and residential complex with public access.

Several parks are located in this segment – all are considered to be water enjoyment facilities and have extensive public access and recreation. Marina Park in downtown Kirkland consists of open space, the docks and piers, a small beach with water access, a boat ramp and a pavilion. As part of the park, there is a surface parking lot that provides parking for park use, dock use and adjacent businesses. Previous studies have identified possible enhancements to the park along with the potential for allowing some limited retail or restaurant use and structured parking. Marina Park is seen as a primary focal point for downtown Kirkland.

4.4.2 Shoreline Modifications

The shoreline of Segment D is the most heavily modified segment, with 90 percent of the shoreline armored at or near the ordinary high water mark, an overwater coverage of 24.1 square feet per linear foot of shoreline (nearly triple the residential segments), and an overwater structure density of approximately 27.2 per mile (approximately half the residential segments (see Tables 7 and 8 above). Many of the piers have one or more boatlifts, but canopies cover only 7 percent of the boatlifts. As indicated by the numbers, Segment D does contain many large piers (public, private marinas, community piers for condominium residents, etc.) that can adversely affect the aquatic environment at a much greater scale than a typical residential pier. They produce significant, large areas of overwater cover, extend much farther into the lake, and may have more potentially polluting activities such as boat repair and fueling. Although specific studies regarding marina-related pollution in Lake Washington could not be located, Appendix F contains a general discussion based on a study conducted by the U.S. Environmental Protection Agency of typical polluting activities that occur at or in association with marinas. Many of these elements apply also to typical residential piers and boating activities in general.

The Argosy Cruises operation is located at the Kirkland City Dock, and uses the Kirkland Yacht Club's wastewater pump-out. Yarrow Bay Marina also houses a wastewater pump-out that is actually owned by the adjacent Carillon Point Marina. Use of this pump-out is free to the public. Kirkland residents, however, have encountered patches of raw sewage while boating in Lake Washington and have reported that raw sewage washes up onto their beaches. If the source is local boaters, then a public education effort may be needed to notify boaters of wastewater pump-out locations and encourage their use. Overwater condominiums are similarly impacting, with large areas of solid over-water cover and densely spaced under-water structures to support the building.

It is not uncommon around Lake Washington for some historic fills to be associated with the original bulkhead construction, usually to create a more level or larger yard. Most of these shoreline fills occurred at the time that the lake elevation was lowered during construction of the Hiram Chittenden Locks. No attempt was made during the field investigation to assess the extent of shoreline fills. The impacts of pier and bulkhead modification on ecological functions are described in detail in Section 5.0.

4.4.3 Critical Areas

Streams. Segment D contains several small streams that collect flow from as far north as the Peter Kirk neighborhood of Kirkland and as far south as the City of Bellevue. Most of these streams have significant portions that flow through underground pipe, especially those drainages which flow through downtown Kirkland and discharge near Marina Park. Out of the seven streams which have been previously inventoried within this segment that discharge to Lake Washington (Figure 13), only one (Carillon Creek) has an open channel at its mouth. This downstream section flows through the Carillon Point complex and has been highly impacted by development. However, restoration with native plants along the stream bank and some large woody debris installation has improved habitat conditions in recent years. Carillon Creek originates from springs and seeps in a wooded ravine upstream of Lake Washington Boulevard.

Wetlands. No wetlands are mapped in this King County segment by any of the reviewed sources (WDFW 2006; King County iMap), nor have hydric soils been mapped in this segment by the NRCS.

Fish and Wildlife Habitat. Segment D does not contain any significant fish or wildlife habitats other than Lake Washington and the streams described above. Residential and commerical development close to the shoreline, with accompanying landscaping and shoreline modifications, has removed much of the potential riparian habitat.

4.4.4 Opportunity Areas

Marina Park (Fish Habitat): This large park located in downtown Kirkland is the focal point for the City of Kirkland's waterfront access. This area includes a small marina, pier, boat ramp, swimming area, and designated shoreline access points. Opportunities exist to improve habitat conditions along the shoreline by reducing overwater cover through the installation of deck grating on the existing piers, removing or minimizing the impacts of shoreline armoring, and improving nearshore native vegetation.

Street-End Park (Reduce Impervious Surface): This small street-end park consists of an adjacent parking area located within the shoreline jurisdiction that likely drains surface runoff directly to Lake Washington. Improvements to stormwater controls could occur if not already completed. Additionally, the future use of pervious material should be explored any time repairs are proposed.

David Brink Park (Fish Habitat): Opportunities exist to improve habitat conditions along the shoreline by reducing overwater cover through the installation of deck grating on the existing piers, removing or minimizing the impacts of shoreline armoring, removing unused remnant pier piles, and improving nearshore native vegetation.

Settler's Landing (Fish Habitat): This small street-end park contains the opportunity to improve shoreline habitat by improving native vegetative cover. The existing shared use pier (public and private) could potentially be re-decked with grated materials to reduce shading impacts.

Marsh Park (Fish Habitat): Several opportunities exist to improve habitat conditions along the shoreline. These include: reduction of overwater cover by the existing pier through the installation of deck grating, removal or minimization of shoreline armoring, and improvement of nearshore native vegetation to improve habitat conditions for juvenile salmonids. The impact of existing impervious surfaces (paved parking areas) could be reduced through the use of pervious materials, relocation, or minimization.

Houghton Beach Park (Fish Habitat): Opportunities exist to improve habitat conditions along the shoreline by reducing overwater cover through the installation of deck grating on the existing piers, removing pier skirting as feasible, removing or minimizing the impacts of shoreline armoring; removal of unused piles; and improving nearshore native vegetation.

General: Many shoreline properties have the potential for improvement of ecological functions through: 1) reduction or modification of shoreline armoring, 2) reduction of overwater cover and in-water structures (grated pier decking, pier size reduction, pile size and quantity reduction, removal of creosote-treated piles, moorage cover removal), 3) improvements to nearshore native vegetative cover, and/or 4) reductions in impervious surface coverage.

See Section 3.11 for discussion of how identified Opportunity Areas within each segment fits into the larger restoration strategy.

5.0 ANALYSIS of ECOLOGICAL FUNCTIONS and ECOSYSTEM WIDE PROCESSES

5.1 LAKE WASHINGTON WATERSHED

The Lake Washington watershed (Water Resource Inventory Area 08 [WRIA 08]) encompasses 692 square miles, collecting water from two major rivers (Cedar and Sammamish Rivers) before flowing through Lake Union and ultimately into Puget Sound via the Lake Washington Ship Canal and Hiram Chittenden locks. The baseline conditions that aquatic species presently face in Lake Washington result from considerable human alterations of the environment.

The following information is presented to give historical context to the analysis of existing ecological functions and processes (i.e. baseline conditions). The urbanization of the Lake Washington watershed has increased impervious area, reduced forest cover, and increased nutrient and chemical loading to environmentally sensitive areas. These factors eventually contribute to increased storm flows, channel incision, sedimentation, and reduction in water quality, to name a few, ultimately impacting downstream receiving water bodies such as Lake Washington. As previously mentioned, the *Salmon and Steelhead Habitat Limiting Factors Report for the Cedar-Sammamish Basin (Water Resource Inventory Area 8)* (Kerwin 2001) identifies the following five “limiting habitat factors and impacts on Lake Washington:”

- The riparian shoreline of Lake Washington is highly altered from its historic state. Current and future land use practices all but eliminate the possibility of the shoreline to function as a natural shoreline to benefit salmonids;
- Introduced plant and animal species have altered trophic interactions between native animal species;
- The known historic practices and discharges into Lake Washington have contributed to the contamination of bottom sediments at specific locations;
- The presence of extensive numbers of docks, piers and bulkheads have highly altered the shoreline; and
- Riparian habitats are generally non-functional.

The lowering of the lake that resulted from the construction of the Lake Washington Ship Canal and Hiram Chittenden locks (completed in 1916) and the concurrent elimination of the Black

River and the diversion of the Cedar River into Lake Washington were the most monumental modifications. Lake Union was connected to Lake Washington via the Montlake Cut, and the former outlet to Lake Union was enlarged to form the Fremont Cut. Locating the locks near the western terminus of Salmon Bay converted the formerly saltwater inlet into a freshwater channel, eliminating over 7 km (4 mi.) of estuarine habitat. Lowering Lake Washington and diverting the Cedar River affected both the fish populations and the condition of the habitat. Cedar River fish stocks were locally adapted to a riverine migration and an extensive estuary, instead of the current lengthy lacustrine migration and an abrupt transition between warm, fresh water and significantly colder, more saline conditions below the locks. Lake Washington fish stocks, while accustomed to the lengthy lacustrine migration, were also adapted to an extensive estuary. The approximately 9-foot reduction in lake level eliminated much of the available shallow-water and freshwater marsh habitat, and decreased the length of the shoreline. Chrzastowski (1983) reports a loss of 15.3 km (9.5 miles) of shoreline, and an estimated loss of 410 hectares (1,013 acres) of wetland resulting from the lowering of the lake.

The construction of the Hiram Chittenden locks and subsequent water level regulation in Lake Washington by the Corps eliminated the annual flood-driven seasonal inundation of the shoreline that historically shaped the structure of the vegetation community. The hardstem bulrush- and willow-dominated community that existed prior to 1916 has been replaced by developed shorelines with landscaped yards. The management of the lake level by the Corps to maintain a high water volume throughout the summer and subsequently lowering the lake during the late fall and winter essentially reverses the natural lake hydrograph. This reversal impacts the growth of many species of native terrestrial and emergent vegetation. Conversely, this hydrograph reversal indirectly acts to buffer shorelines from potential wind-driven wave impacts during winter storms. The loss of natural shoreline has reduced complex shoreline features such as overhanging and emergent vegetation, woody debris (especially fallen trees with branches and/or rootwads intact), and gravel/cobble beaches. Evermann and Meek (1897) noted in 1896 that “the shore of Lake Washington is not well adapted to collecting with a seine” due to the abundant submerged woody debris, and dense underbrush, small trees, and tule (hardstem bulrush) that fringed the shoreline. The loss of native shoreline vegetation and wetlands has also reduced allocthonous input of detritus and terrestrial insects.

The woody debris, once abundant along the shoreline of Lake Washington in its historical condition has been replaced with structurally simple piers. A survey of 1991 aerial photos estimated that 4 percent of the shallow-water habitat within 30.5 m of the shore was covered by residential piers (ignoring coverage by commercial structures and vessels) (Malcom, pers. comm., 22 November 1999). A study conducted in 2000 reported that there were 2,737 docks in Lake Washington, and that approximately 71 percent of the shoreline was armored (Toft 2001). The loss of complex habitat features (i.e., woody debris, overhanging vegetation, emergent vegetation), and shallow-water habitat in Lakes Washington and Sammamish has reduced the availability of prey refuge habitat and forage for juvenile salmonids. As NOAA Fisheries- and USFWS-mandated standard conservation measures are implemented with individual shoreline projects, and bioengineering methods and other “fish-friendly” designs for shore protection are adapted to lakeshore use, the condition of the Lake Washington shoreline, in terms of fish and wildlife habitat may improve over time. However, the present availability of quality shoreline habitat for salmonids and their prey species remains substantially below its historical level. Recent and ongoing efforts to address the concern of growth management within the watershed and facilitate recovery efforts for salmon and salmon habitat, specifically for chinook salmon, include working with local jurisdictions to implement shared strategies for salmon recovery (WRIA 8 Steering Committee 2005; WRIA 8 Steering Committee 2002).

While water quality in Lake Washington is often considered moderate to good, the present state is a tremendous improvement from its condition just 50 years ago. Prior to the formation of Metro (now part of King County's Department of Natural Resources and Parks) in 1958, local sewage treatment plants around Lake Washington discharged effluent directly into the lake, resulting in large cyanobacteria (*Oscillatoria rubescens*) blooms that made the lake unsafe for recreation. After the construction of regional wastewater treatment facilities in Renton and at West Point in Seattle, effluent discharges dropped from approximately 20 million gallons per day to zero (Edmondson 1991). The subsequent reduction in phosphorus loading from the effluent discharges resulted in relatively immediate improvements to the lake's water quality. While water clarity was measured to be only 30 inches in 1964, clarity improved to 10 feet by 1968, reaching 25 feet by 1993.

A key feature of urban areas is impervious surface coverage. Increases in impervious surface coverage, and the consequent reduction in soil infiltration, have been correlated with increased velocity, volume and frequency of surface water flows. This hydrologic shift alters sediment and pollutant delivery to streams and ultimately to downstream receiving water bodies (Booth 1998; Arnold and Gibbons 1996). Increased surface water flows associated with impervious surface coverage of suburban areas (20-30%) has been linked to decreased bank stability and increased erosion (May et al. 1997a). Knutson and Naef (1997), in their literature review, concluded that as little as 10 percent impervious surface coverage is sufficient to alter streambank stability and erosion. Changes in hydrology and stream morphology brought on by impervious surfaces have also been linked to shifts in macroinvertebrate community composition, which could have profound and far-reaching impacts on the productivity of a watershed (Pederson and Perkins 1986, as cited in Leavitt 1998). Changes in fish assemblages have been correlated with changes in stream temperature and base flow as a result of increased impervious surface coverage (Wang et al. 2003). Increases in flood frequency and volume have been correlated to declining salmon populations in some Puget Sound lowland streams (Moscrip and Montgomery 1997). Riparian areas can protect against these factors by moderating surface water and sediment inputs. However, while riparian quality has been shown to be inversely proportional to the level of urbanization (May et al. 1997b), impervious surface area alone is not the only component to predicting stream biological conditions (Booth et al. 2004).

Many concerns have arisen in recent years over the impacts from the urbanization of predominantly forested areas, especially areas which contain erosion-susceptible geologic substrate and relatively high gradients (Booth and Henshaw 2001). Booth et al. (2002) conclude that under typical rural land uses, impacts to watershed ecology from reduced forest-cover area can be as great or greater than similar increases in impervious area. Threshold levels of 10 percent impervious coverage and 35 percent deforested area have been found to mark a distinct transition towards severely degraded stream conditions (Booth 2000).

In general, development is known to have detrimental effects on salmonids, particularly with spawning abundance and success. Pess et al. (2002) found that wetland occurrence, local geology, stream gradient, and land use were significantly correlated with adult coho salmon abundance. While positive correlations were found between spawner abundance and forested areas, negative correlations were found between spawner abundance and areas converted to agriculture or urban development. Fish species diversity has been found to decline with increasing levels of urban development, while cutthroat trout tend to become the dominant salmonid species (Lucchetti and Fuerstenberg 1993; Ludwa et al. 1997). The WRIA 8 Steering Committee has recently recognized the need to restore coho salmon spawning habitat in order to reduce the population of cutthroat trout, a known predator of juvenile chinook salmon (WRIA 8 Steering Committee 2005).

The remainder of this discussion describes the baseline conditions within Lake Washington in terms of the following parameters as enumerated by NOAA Fisheries' draft Lake Matrix of Pathways and Indicators established for chinook salmon (Table 17): 1) water quality, 2) habitat access, 3) habitat elements, 4) shoreline conditions.

Table 17. Checklist for Documenting Environmental Baseline of Relevant Indicators – Draft modified by NOAA Fisheries for lakes.

PATHWAYS INDICATORS	**SUMMARY OF LAKE WASHINGTON CONDITIONS**
Water Quality	
Temperature/Dissolved Oxygen	At Risk: Surface water temperatures often exceed the critical threshold for juvenile salmonids, creating inhospitable shallow nearshore areas typically between July and October. However, juvenile salmonids are not likely to be present in the nearshore at this time of year. Conversely, DO rarely falls below acceptable levels in surface waters (1-10m). However, DO concentrations below dense growths of aquatic macrophytes, Eurasian milfoil in particular, can be lethally low.
pH	At Risk: pH levels are found typically within acceptable levels, but can become higher during the late spring/early summer months.
Chem. Contamination	At Risk: Chemical contamination consists primarily of hydrocarbon input from the urbanized watershed, but the lake has also been on the 303d list for fecal coliform, ammonia, and PCBs.
Nutrients/Total P	At Risk: Nutrient levels in Lake Washington typically do not represent a problem for salmonids. However, localized algal blooms have occurred at various points throughout the lake.
Habitat Access	
Physical Barriers	At Risk: While fish passage is not physically blocked by the locks, the barrier presented by the locks and corresponding fish ladder causes stress and mortality for migrating salmonids.
Habitat Elements	
Exotic Species (in water)	Not Properly Functioning: Many invasive aquatic plants, such as Eurasian milfoil, have become extremely prevalent throughout the lake, often times outcompeting native species and reducing overall structural complexity.
Shoreline Upwelling/ Downwelling	Not Properly Functioning: The extent of shoreline armoring has reduced the natural influx of gravel via erosion processes and increased rates of sediment transport, which in turn has decreased the extent of shoreline upwelling/downwelling.

PATHWAYS INDICATORS	SUMMARY OF LAKE WASHINGTON CONDITIONS
Structural Complexity (LWD/emergent/ submergent vegetation)	At Risk: Much of the loss in structural complexity dates back to the lowering of the lake by the U.S. Army Corps of Engineers during construction of the Hiram Chittenden Locks. The manual control of the lake elevation and the subsequent reversal of the natural hydrograph does not support the natural establishment of emergent vegetation similar to the historical condition. Shoreline development has decreased shoreline vegetation and subsequently removed and prevented further additions of LWD.
Substrate Composition	Not Properly Functioning: Due to the extent of shoreline armoring around Lake Washington, which effectively limits the natural erosion processes leading to sediment transport, the composition of most shoreline substrates do not contain habitat suitable to most salmonids. The extensive armoring also results in a lack of habitat structure used for rearing and allocthonous inputs necessary to support foraging. Juvenile salmonids primarily feed on aquatic and terrestrial invertebrates. The lack of overhanging and emergent vegetation limits allocthonous input of both detritus and invertebrates.
Shoreline Conditions	
Shoreline Vegetation and Riparian Structure	Not Properly Functioning: Residential development around much of the lakeshore has resulted in a general lack of shoreline vegetation and riparian structure. The historical shoreline of Lake Washington included a mix of willow, dogwood, and other large shrubs along with upland conifers. The development of the lakeshore has effectively removed this native vegetation and replaced it with small shrubs and grass lawns, neither of which provide the habitat complexity of the historical shoreline.
Shoreline Gradient	Not Properly Functioning: Similar to the concerns regarding Shoreline Upwelling/Downwelling and Substrate Composition, Shoreline Gradient has also been negatively affected by shoreline armoring.

1. <u>Water Quality</u>: In general, Lake Washington surface water temperatures between 1 and 10 meters deep exceed 17°C from July to October. This temperature appears to be a critical threshold for the distribution of juvenile anadromous salmonids. The expectation is that shallow nearshore areas of Lake Washington would be inhospitable for bull trout and juvenile chinook and coho salmon during periods of high temperatures.

   Conversely, dissolved oxygen (DO) levels rarely fall below 8 mg/L at similar depths. DO levels below 4 mg/L are considered dangerous for salmonids. Thus, ambient DO levels exceed acceptable levels for salmonids. However, DO concentrations below dense growths of aquatic macrophytes, Eurasian water-milfoil in particular, can be lethally low (Frodge et al. 1995).

   From 1995 through 2000, measures of pH at a 1-meter depth (King County Metro monitoring station 0840) were typically between 7 and 9, exceeding 8.5 during most years in the late spring/early summer months. A pH of 9 was exceeded one time in May of 1999. At 10-meter depths, pH was never measured above 9. Other water quality concerns include chemical contaminants and fecal coliform levels. Lake Washington was on the U.S. EPA 2004 303(d) list for fecal coliform at fifteen sample locations, ammonia at two locations, and polychlorinated biphenyls (PCBs) at one location. Chemical contamination of the waters of

Lake Washington consists primarily of hydrocarbon input from the urbanized watershed. Wakeham (1977) computed a hydrocarbon budget for Lake Washington and determined that the majority of the hydrocarbons were from stormwater runoff either directly to the lake or via rivers, while 85 percent of the hydrocarbon removal is via sedimentation. Wakeham (1977) indicated that the primary source of hydrocarbons in the urban runoff to Lake Washington is automotive, both oil and grease, and products of combustion (polycyclic aromatic hydrocarbons - PAHs); outboard engine operation likely contributes a very small fraction of total input (less than 1%). PAHs are a common pyrolytic byproduct of all internal combustion engines and are now commonly found in most aquatic systems, near industrialized and urbanized centers (Green and Trett 1989).

Overall, relatively little is known about the impacts of PAHs to aquatic organisms. Arkoosh et al. (1998) reported evidence for immunosuppression resulting from exposure to PAHs, determining that chinook smolts from urban estuaries (Duwamish) exhibited a higher cumulative mortality after exposure to the marine pathogen *Vibrio anguillarum* than smolts from a non-urban estuary. Tissue examinations of the chinook smolts indicated that those from the urban estuary had been exposed to higher levels of PAHs and PCBs than smolts from the non-urban estuary (Arkoosh et al. 1998).

Present nutrient levels in Lake Washington do not represent a problem for salmonids. Total phosphorus, as measured from 1995 through 2000 at Metro station 0840, varied little between seasons, and has generally been below 4 mg/L.

The *Final Lake Washington/Cedar/Sammamish Watershed (WRIA 8) Chinook Salmon Conservation Plan* listed Lake Union, the Ship Canal and the Sammamish River as waterbodies with degraded water quality, but did not include Lake Washington (WRIA 8 Steering Committee 2005). The *Lake Washington Existing Conditions Report* (Tetra Tech ISG, Inc. and Parametrix, Inc. 2003) summarizes and analyzes 12 years of water quality data. The Report concludes the following:

> "Overall, Lake Washington has recovered from the eutrophic, over enriched state that existed in the 1950s to 1960s. The key to rapid recovery was the lake's depth, which contained large stores of dissolved oxygen and the reduction in P loading that occurred with sewage diversion. The lake is sensitive to P loading, and the maintenance of present-day water quality is dependent on keeping P loading at or below current levels. Minimal development of the Cedar River basin has been a key factor in recovery and maintenance of lake water quality."

2. <u>Habitat Access</u>: The Hiram Chittenden Locks represent a barrier to fish passage by creating a combination of physical and biological obstacles to fish migration. While fish passage is not physically blocked by the locks, the physical and biological obstacles that the locks create, result in a significant level of stress and mortality for adult and juvenile salmonid migrants.

3. <u>Habitat Elements</u>: Exotic aquatic plant and animal species inhabit much of the Lake Washington system. Milfoil and fragrant white water lily are exotic aquatic macrophytes in Lake Washington that have demonstrated a negative affect on fish on occasion (Frodge et al.

1995). Reduced DO levels and consequent fish mortality has been observed within dense patches of either species in shallow, poorly circulating water (Frodge et al. 1995). Low DO conditions under aquatic macrophytes have only been observed in small lakes or in sheltered bays of Lake Washington. Yellow perch, brown bullhead, smallmouth bass, and largemouth bass are exotic predators with the potential to prey on juvenile chinook and coho salmon. Yellow perch utilize “non-structural” areas (Paxton and Stevenson 1979) and brown bullhead are benthic foragers, and are thus less likely than bass to utilize developed areas. Yellow perch of piscivorous size are also generally limnetic. Largemouth bass are the most likely exotic predators in nearshore areas because of the abundant aquatic vegetation. Observing where sockeye salmon beach spawn best identifies the presence of shoreline upwelling or downwelling in Lake Washington. While sockeye spawning locations have been mapped by WDFW, very little beach spawning has been documented in recent years. Shoreline hardening and the lack of erodible soils and subsequent sediment drift has likely resulted in a negative impact to shoreline upwelling/downwelling conditions.

Structural complexity in Lake Washington currently consists of submerged aquatic macrophytes, some small and large woody debris primarily located along undeveloped shorelines, and piers or other man-made in-water structures. The lake is generally lacking in structural complexity relative to natural shorelines. The implications for juvenile salmonids are that the present lack of complex structure throughout most of Lake Washington provides an advantage to large piscivorous fish.

Substrate composition throughout Lake Washington is influenced by shoreline hardening, which restricts erosional sediment input. Without supplemental substrate to cover and replace contaminated areas, exposed areas with high levels of PCBs and PAHs may be available to impact the aquatic food chain. Although not specifically studied in Lake Washington, immunosuppression responses have been observed in salmonids migrating through similar Puget Sound urban areas (Arkoosh et al. 1998). Lake Washington was on the U.S. EPA 1998 303(d) list for sediment bioassay at one location near the mouth of May Creek and the 2004 303(d) list of PCBs for one location near the north end of Lake Washington. While these locations are not specifically along the City or PAA shoreline, they are within the same waterbody and can affect the aquatic food chain lake-wide. Thus, discussion of water quality impacts, especially those derived by anthropogenic effects, is warranted.

4. <u>Shoreline Conditions</u>: The urbanization of the Lake Washington shoreline has resulted in a shoreline generally lacking native vegetation. There are very few sources of woody debris recruitment that remain and these are primarily associated with the only remaining undeveloped shorelines. The result is a lack of habitat structure used for rearing and allocthonous inputs necessary to support foraging. Juvenile salmonids primarily feed on aquatic and terrestrial invertebrates. The lack of overhanging and emergent vegetation limits allocthonous input of both detritus and invertebrates.

5.2 EFFECTS OF SHORELINE MODIFICATIONS ON AQUATIC ORGANISMS AND THEIR HABITATS

Shoreline modifications and nearshore structures around Lake Washington have dramatically altered the lake's aquatic ecosystem. Although some changes in the Lake environment are not completely understood, the effects of physical modifications to shoreline habitats on some aquatic species, particularly chinook salmon, have been very well studied. Because of their sensitivity to changes in the aquatic ecosystem, anadromous salmonids are commonly used as a biological indicator species for the aquatic health of Lake Washington. There are many indigenous aquatic species inhabiting Lake Washington, but salmonids are one of the most sensitive. Due to their "threatened" status under the ESA, funding and other resources have been made available for the study of chinook salmon utilizing Lake Washington, which are an important part of the Puget Sound Chinook Salmon Evolutionary Significant Unit (ESU). The life history pattern and habitat requirements of the chinook salmon reflects the needs of other salmonid and non-salmonid aquatic species indigenous to Lake Washington, and information concerning the chinook salmon serves as a good proxy for other species in the Lake. Similarly, habitat restoration efforts designed to benefit chinook or other salmonids will also be beneficial for other native species inhabiting Lake Washington.

An important part of the City, the Kirkland waterfront has been extensively modified with bulkheads, piers, and other overwater structures (Toft 2001). Common modifications to nearshore aquatic habitats around much of Lake Washington include 1) the construction of bulkheads, which result in the structural simplification of shoreline habitats, and 2) the construction of piers, which block sunlight and create large areas of overhead cover within the littoral zone. These types of structural modifications to shorelines are now known to benefit non-native predators (like largemouth and smallmouth bass), while reducing the amount of complex aquatic habitat formerly available to salmonids rearing and migrating through Lake Washington (Kahler et al. 2000; Kerwin 2001; Tabor et al. 2006). Adult salmonids tend to utilize deepwater habitats in Lake Washington and structural changes to nearshore habitats typically have a lesser affect on adults than they do on juvenile salmonids. Lake Washington serves as an important rearing area and migration corridor for juvenile salmonids, however, and due to their affinity to nearshore, shallow-water habitats, juvenile salmonids are greatly affected by physical changes at the shoreline.

5.2.1 Anadromous Fish in the Lake Washington Watershed

Adult chinook salmon migrate from Puget Sound through the Chittenden Locks and into Lake Washington between July and September, continuing on to various tributary streams where they spawn in October and November. Although most chinook salmon production in the Lake Washington watershed occurs in the Cedar River, the North Lake Washington tributary streams (feeding into the Sammamish River), or at the Issaquah Fish Hatchery, chinook salmon (as well as coho and sockeye) also use many other, smaller Lake Washington tributary streams. A few of the tributary streams in or near the Kirkland area that are used by chinook salmon or other anadromous salmonids include Juanita Creek, Yarrow Creek, Forbes Creek, and Kelsey Creek. Chinook fry emerge from their redds between January and March, and either rear in their natal stream or emigrate to Lake Washington for a rearing period extending from three to five months. Emigrating through the Chittenden Locks and into Puget Sound between May and August, juvenile chinook salmon leave the Lake Washington system during their first year (Kerwin 2001; Tabor and Piaskowski 2002). Other anadromous salmonids spawning and/or rearing in the Lake Washington watershed include sockeye salmon, coho salmon, steelhead trout, and possibly bull trout.

After emerging from the gravel, chinook fry from Lake Washington tributaries either emigrate directly to the Lake, or rear to the fingerling stage in their natal stream before entering the Lake (Seiler et al. 2005). This process occurs between February and June. After they enter Lake Washington, juvenile chinook often congregate near the mouths of tributary streams, and prefer low gradient, shallow-water habitats with small substrates (Tabor and Piaskowski 2002; Tabor et al. 2004b; Tabor et al. 2006). Chinook fry entering Lake Washington early in the emigration period (February and March) are still relatively small, typically do not disperse far from the mouth of their natal stream, and are largely dependant upon shallow-water habitats in the littoral zone with overhanging vegetation and complex cover (Tabor and Piaskowski 2002; Tabor et al 2004b). The mouths of creeks entering Lake Washington (whether they support salmon spawning or not), as well as undeveloped lakeshore riparian habitats associated with these confluence areas, attract juvenile chinook salmon and provide important rearing habitat during this critical life stage (Tabor et al. 2004b; Tabor et al. 2006). Later in the emigration period (May and June), most chinook juveniles have grown to fingerling size and begin utilizing limnetic areas of the Lake more heavily. As the juvenile chinook salmon mature to fingerlings and move offshore, their distribution extends throughout Lake Washington. Although early emigrating chinook fry from the Cedar River and North Lake Washington tributaries (primary production areas) initially do not disperse to shoreline areas in Kirkland, any salmon fry from smaller tributaries such as Juanita, Forbes, or Yarrow Creeks would depend on nearshore habitats of the Kirkland waterfront. Later in the spring (May and June), however, juvenile chinook are known to be well distributed throughout both limnetic and littoral areas of Lake Washington, and certainly utilize shoreline habitats in Kirkland.

5.2.2 The Effects of Overwater Shading and Shoreline Armoring

Piers and other overwater structures shade the lake bottom and inhibit the growth of aquatic vegetation. Overwater structures affect the size, density, and species composition of aquatic macrophytes living directly beneath them (Fresh and Lucchetti 2000). The magnitude of this effect on aquatic macrophytes varies with the size (square footage) of the structure and the amount of sunlight it blocks. Changes in the physical structure of the aquatic plant community affect juvenile salmonids, as well as other indigenous fishes that use this vegetation in the nearshore environment. Spatial heterogeneity in aquatic vegetation increases the amount of edge habitat, improving the quality of foraging habitat available to ambush predators like the bass (Bryan and Scarnecchia 1992; Weaver et al 1997; Kahler et al. 2000). The combined effect of an overwater structure and a dramatic change in aquatic vegetation results in a behavior modification in juvenile salmonids moving through both littoral and limnetic habitats. Juvenile salmonids migrating parallel to the shoreline will often change course to circumvent large piers or other overwater structures rather than swimming beneath them (Tabor and Piaskowski 2002; Tabor et al. 2004b; Tabor et al. 2006). These behavior modifications disrupt natural patterns of migration and can expose juvenile salmonids to increased levels of predation. Minimizing overwater coverage and associated support structures will benefit salmon fry rearing in the littoral zone as well as older salmon fingerlings utilizing the limnetic zone. Studies related to shading effects from varying types of pier decking indicate that grated decking provides significantly more light to the water surface than traditional decking methods and may lead to improved migratory conditions for juvenile chinook salmon (Gayaldo and Nelson 2006).

Bulkheads or other types of shoreline armoring affect juvenile salmonids by eliminating shallow-water refuge habitat, or indirectly, by the elimination of shoreline vegetation and in-water woody debris that generally accompanies bulkhead construction. Placing bulkheads waterward of OHWM creates an abrupt, deep-water drop-off at the shoreline while eliminating shallow water habitat in the nearshore. Lange (1999) found that bank stabilization (i.e., various forms of erosion control structures that we refer to as "bulkheads") was negatively correlated to fish abundance and species richness at all spatial scales investigated. Juvenile chinook salmon and other small fishes rely on shallow-water habitats in the littoral zone for foraging, refuge, and migration (Collins et al. 1995; Tabor and Piaskowski 2002). Shoreline armoring and bulkheads are also known to result in local reductions to the species diversity and abundance of both the fish community as well as the macroinvertebrate population inhabiting the littoral zone (Schmude et al. 1998; Lange 1999; Jennings et al. 1999).

5.2.3 Predator-prey Interactions in Lake Washington

Indigenous Lake Washington fish species that prey on juvenile salmonids include cutthroat trout, rainbow trout, coho salmon, northern pikeminnow, five species of sculpin, and lamprey. Non-native predators currently present in the Lake include smallmouth bass, largemouth bass, and yellow perch. Native cutthroat trout populations (adfluvial and anadromous) are strong in Lake Washington, and this species is currently considered the primary predator of juvenile chinook, sockeye, and coho salmon. Smaller-sized cutthroat trout prey on juvenile salmonid fry inhabiting the littoral zone early in the spring, while larger individuals feed on salmonid fingerlings migrating and rearing in the limnetic zone later in the season (Nowak et al. 2004; Tabor et al 2004a). A small proportion of northern pikeminnow, yellow perch, and smallmouth bass reside in nearshore regions during winter, but the majority moves offshore in the spring as temperatures in nearshore areas warm (Bartoo 1972; Olney 1975; Coutant 1975). The distributions of these fishes overlap primarily with the peak out-migration of chinook through the littoral zone, whereas the overlap of cutthroat and chinook distributions is continuous. Sculpins are present in the littoral zone year-round and are also known to eat juvenile chinook salmon (Tabor et al. 1998; Tabor et al 2004a). In mid-summer, temperatures in the littoral zone become undesirable for juvenile chinook and coho salmon, and the majority leave the lake or seek cooler temperatures away from the littoral zone, thus segregating themselves from littoral predators, but remaining vulnerable to cutthroat trout and potentially prickly sculpin.

Shoreline development could potentially increase the rate of predation on juvenile salmonids by several principal means: 1) reducing the amount of refuge habitat available to prey species like juvenile salmonids by modifying the structure of the shoreline; 2) providing concealment structures for ambush predators such as bass and sculpin; 3) providing artificial lighting that allows for around-the-clock foraging by predators; and 4) altering migration routes for smolts and rearing fry. Although many predators that feed on juvenile salmonids are active, cruising hunters (i.e., other salmonids, piscivorous birds, northern pikeminnow), smallmouth and largemouth bass generally utilize ambush or habituation foraging strategies (Hobson 1979). Fayram and Sibley (2000) determined that smallmouth bass in Lake Washington occupied littoral home ranges that radiated 100 to 200 meters from the focal point and generally did not extend below 8-meter depths. Because of their propensity for ambush foraging and shoreline orientation, bass in Lake Washington benefit from artificial structures placed in the littoral zone, whereas yellow perch are more likely to utilize "non-structural" areas (Paxton and Stevenson 1979). Increased useage of complex cover (e.g., aquatic vegetation, woody debris, substrate interstices, and undercut banks) by prey fishes in the presence of predators, and reduced foraging efficiency of predators due to habitat complexity has been well documented (Wood and Hand 1985; Werner and Hall 1988; Bugert and Bjornn 1991; Tabor and Wurtsbaugh 1991; Persson and Eklov 1995). Juvenile salmonids, like many other prey species, modify their behavior in the presence of predators by seeking or orienting to complex refuge (Gregory and Levings 1996; Reinhardt and Healey 1997), emigrating from areas with predators (Bugert and Bjornn 1991), aggregating (Tabor and Wurtsbaugh 1991), and adopting diel vertical migrations (Eggers et al. 1978). Complex habitat features that exclude predators, physically or through risk-aversion can function as prey refuge. Examples of effective prey refuge include complex substrate, aquatic and emergent vegetation, overhanging terrestrial vegetation, undercut banks, and submerged pieces of large wood. Shallow water also functions as a refuge from predation for small fish, especially in the absence of complex habitat features such as woody debris or submerged vegetation. Historically, Lake Washington's riparian and littoral zones were well vegetated, and interspersed with an abundance of large wood that had fallen along the shoreline (Evermann and Meek 1897; Stein 1970). The lowering of the Lake Washington water level and substantial shoreline development eliminated much of the vegetation and structural complexity historically available to juvenile salmonids rearing and migrating in the nearshore. Management plans seeking to encourage healthy assemblages of native fish should avoid the simplification of shoreline habitat, and the reduction of refuge-habitat for prey species.

Although the magnitude of avian predation in Lake Washington is unknown, piscivorous birds are present and this source of predation must be considered among potential threats to most fish, including juvenile salmonids. Common mergansers are abundant in the spring. Double-crested cormorants are common in Lake Washington, typically perching on the log booms at Union Bay and May Creek rather than on docks and bulkheads. Cormorants also commonly perch on individual piles. Western grebes inhabit enclosed bays (and some marinas), and forage throughout the lakes on calm days. Gulls are common, perching on log booms and on low docks, and are also known to feed on juvenile salmonids (Ruggerone 1986). In-water structures provide perching platforms for avian predators, from which they can launch feeding forays or dry plumage (Kahler et al. 2000). Incorporating anti-perching devices and grating in the design of overwater piers or related structures would work to minimize any advantage these structures convey to piscivorous birds.

5.2.4 Non-native Predators in the Nearshore Environment

The habitat requirements and behavior patterns of bass species have been studied extensively throughout their range, including Lakes Washington and Sammamish. A growing body of bass-related research has collectively demonstrated that bass species have an affinity for structural elements, and that bass prey on juvenile salmonids in Lake Washington. Smallmouth bass are more abundant in Lake Washington than largemouth bass, but both species are present in the system.

Although smallmouth and largemouth bass are known to prefer natural cover types like brush, logs, aquatic vegetation, or boulders (Stein 1970), these adaptive species readily utilize floating docks and the support piles of piers in the absence of natural cover types. Artificial structures and cover types that promote shade or darkness are frequently favored by yearling bass species (Haines and Butler 1969; Bassett 1994). Bass species are known to select low-gradient, shallow-water (0.6-1.5 meters), silty to gravelly habitats near structural features for spawning (Pflug 1981; Heidinger 1975; Allan and Romero 1975), and prefer similar habitat types near cover while foraging or resting (Vogele and Rainwater 1975). Although the habitat preferences of largemouth and smallmouth bass are generally similar, smallmouth bass generally select drop-offs or outcroppings, cover in the form of logs or rocks, and hard substrates without aquatic vegetation (Pflug 1981; Pflug and Pauley 1984), whereas largemouth bass generally prefer softer-bottom substrates and aquatic macrophytes (Coble 1975). These aspects of bass ecology are consistent with observations of bass behavior from across their geographic range (Bryan and Scarnecchia 1992; Kraai et al. 1991; Bassett 1994).

Logs, brush, or other pieces of large wood are rare along developed sections of the shoreline within the City of Kirkland. Piers provide alternative sources of shade, overhead cover, and in-water structure (piles and boatlifts) that attract bass (Fresh et al. 2003). Piers and piles differ from natural cover/structure elements, such as brush piles, primarily in their lack of structural complexity. This difference is critical for prey fish, which rely on structural complexity for avoidance cover in the presence of predators. In developed lakes, piers become the dominant structural features, at the expense of natural complex structures such as woody debris and emergent vegetation (Bryan and Scarnecchia 1992; Poe et al. 1986; Lange 1999). In areas of Lake Washington where smallmouth bass are present, they preferentially select habitats beneath piers and near in-water support pilings (Fresh et al. 2003). Lake Washington smallmouth concentrations tend to be highest around large docks extending over deeper water, equipped with skirting and numerous support piles. Management plans designed to minimize any advantage non-native predators hold over juvenile salmonids in the littoral zone of Lake Washington should also seek to minimize the amount of overwater cover and support structure associated with pier or dock projects along the shoreline.

5.3 CITY OF KIRKLAND SHORELINE JURISDICTION

5.3.1 Summary of City's Analysis

The segment-specific discussion in Section 4 adequately summarizes existing conditions for most of Kirkland's shoreline jurisdiction, including the PAA. Section 5.1 presents lake-wide conditions and function/process performance, with the latter organized per NOAA Fisheries' draft *Lake Matrix of Pathways and Indicators* established for chinook salmon (see Table 17). The latter discussion is focused on the aquatic lake environment, not the associated upland shoreline areas. The following discussion ties together Sections 4 and 5.1 consistent with the lake function delineation as presented in WAC 173-26-201(3)(d)(i)(C) and the processes outlined in WAC 173-26-201(3)(d)(i)(D). Table 18 summarizes the performance of ecological functions of Segments A, C and D. Segment B (Juanita Bay and Yarrow Bay Wetlands) is a notable exception, and is summarized in Table 19.

Table 18. Function Summary of Segments A, C and D.

Function	**Performance**
Hydrologic	
Storing water and sediment	LOW-MODERATE: The lake of course provides excellent water and sediment storage functions. However, the uplands have low water and sediment storage functions. Impervious surfaces and compact managed lawns interfere with infiltration of precipitation and rapidly send water "downstream." Wetlands and other natural water and sediment storage features are generally lacking.
Attenuating wave energy	LOW: The changes to the lake elevation per the 1916 modifications made the nearshore environment generally steeper, with less opportunity for gradual nearshore slopes to attenuate wave energy. Bulkheading and other shoreline modifications have further steepened the nearshore. However, the reversal of the natural lake hydrograph has ameliorated the affects somewhat.
Removing excess nutrients and toxic compounds	LOW: The upland shoreline areas are more often a source of nutrients and toxic compounds, via lawn treatment runoff (pesticides, fertilizers, herbicides) and road runoff (hydrocarbons, metals).
Recruitment of LWD and other organic material	LOW: Upland modifications restrict the ability of the lake to recruit LWD and organic material.
Vegetation	
Temperature regulation	LOW: Lack of dense shoreline vegetation eliminates potential for some shading of the shallow-water nearshore area. However, most of the City's shoreline is west-facing, so afternoon sun may be a larger factor in nearshore water temperatures than the absence of vegetation.
Water quality improvement	LOW: Residential areas dominated by lawn and landscaping, but without dense buffers of lakeside vegetation, are sources of water quality contaminants such as fertilizers, herbicides and pesticides. In Segment D, runoff from the urban impervious surfaces is also not filtered through any vegetation. In addition to the residential pollutants, urban runoff carries hydrocarbons, metals, sediments and other pollutants from roads and parking lots.
Attenuating wave energy	LOW: Prior to construction of the Locks and subsequent lowering of the lake elevation, the lake was ringed with emergent wetlands and mature mixed-forest communities. Those communities are now almost entirely absent in these segments, so vegetation does not provide any significant wave attenuation function.
Sediment removal and bank stabilization	LOW: Under natural conditions, there would be a certain rate of shoreline erosion, which is essential to maintaining substrate conditions. This rate would be partially determined and moderated by the presence of shoreline vegetation whose root systems would hold bank material in place. Instead, these segments have little shoreline vegetation and approximately 76-90% of the shoreline is armored. While this "stabilizes" the banks, it limits natural recruitment of lakebed materials. Non-armored banks did not appear to be unstable.
LWD and organic matter recruitment	LOW: Again, loss of shoreline vegetation other than lawn and some landscaping has largely eliminated large woody debris and organic matter recruitment potential within these segments. Any trees or large debris that do enter the lake are likely to be quickly removed to reduce risk of property damage or harm to humans.

Function	Performance
Hyporheic	
Removing excess nutrients and toxic compounds	LOW-MODERATE: The hyporheic zone is restricted by extensive shoreline armoring, but likely does provide some nutrient and toxic compound removal when water from the uplands infiltrates into the hyporheic zone instead of running off the surface. Lake water quality is generally good (see previous discussions), but further improvements are likely when upland runoff moves through the hyporheic zone.
Water storage	LOW-MODERATE: Again, the hyporheic zone is restricted by shoreline armoring, although the water storage function is of low importance in a managed lake. Quantitative data are not available.
Support of vegetation	LOW: Much of the shoreline zone within range of the hyporheic zone is vegetated with lawn, which is not generally supported by hyporheic water storage, but instead, by irrigation or precipitation.
Sediment storage and maintenance of base flows	LOW: The hyporheic zone is restricted by extensive shoreline armoring, which limits movement of fines from the lake into the hyporheic zone. However, neither sediment composition nor base flows are particularly important in Lake Washington.
Habitat	
Physical space and conditions for life history	LOW: Under natural conditions, the lake bottom would gradually rise in a shallow wedge such that incoming waves would roll up the bottom, losing energy. This reduced energy environment would be more hospitable to emergent vegetation, which further attenuates wave energy, providing a refuge for small fish and amphibians. Shallow nearshore areas in Lake Washington provide critical rearing, foraging and migration habitat for fish, particularly salmonids. Shoreline armoring, however, generally eliminates the low-energy shallow-water environment, creating a deeper, turbulent nearshore that is inhospitable to small fish and amphibians, as well as to emergent vegetation. Shoreline armoring can also reduce upwelling/downwelling areas, which are optimal for sockeye salmon spawning. The deeper water also allows larger fish predators to prey on the small fish. Aquatic mammals, like muskrats, seem to have adapted to the armored shoreline, and still find den sites in the looser boulder bulkheads. The absence of dense shoreline vegetation is a limiting factor in terrestrial species (birds, mammals, amphibians) use of the shoreline, since cover, food, nesting sites, travel corridors, etc. are absent.
Food production and delivery	LOW: Food production from the uplands is very limited by lack of native seed- and fruit-bearing vegetation. Not only does upland vegetation provide food directly for terrestrial wildlife, but it is a source of insects and other organic matter that drop into the water and provide food for fish and other aquatic life. The historical emergent wetland areas that are now absent also provided productive foraging areas for small mammals, wading birds and waterfowl.

Table 19. Function Summary of Segment B.

Function	Performance
Hydrologic	
Storing water and sediment	HIGH: The lake of course provides excellent water and sediment storage functions. And as described above in detail in Section 4.2.4, Juanita Bay in particular is storing more than its share of sediment input by Juanita Creek. The Forbes Creek/Juanita Bay wetlands and the Yarrow Bay Wetlands likely provide excellent sediment storage functions.
Attenuating wave energy	HIGH: The shallow shoreline gradients in this segment (combined with the emergent vegetation) provide excellent wave attenuation.
Removing excess nutrients and toxic compounds	HIGH: The low-energy nearshore environment in Yarrow Bay and the south shore of Juanita Bay along with their aquatic/emergent vegetation and associated upland wetlands likely take up nutrients and other pollutants.
Recruitment of LWD and other organic material	MODERATE: The lake likely recruits abundant organic materials from the Yarrow Bay Wetlands and Juanita Bay wetlands. LWD recruitment is still relatively low, primarily as a function of upland shoreline modifications and barriers to LWD movement from the streams.
Vegetation	
Temperature regulation	MODERATE: Substantial portions of upland Segment B are densely vegetated, although this vegetation likely does not have a measurable affect on lake water temperature. Near the lake edge, much of the vegetation is either emergent or scrub-shrub wetland, and the orientation to the sun still plays a role. The dense patches of submerged aquatic vegetation, in combination with shallow water, disrupts normal circulation of cooler lake water into the sun-warmed shallow areas.
Water quality improvement	HIGH: This segment does have opportunity to improve water quality. Numerous stormwater outfalls ring the Yarrow Bay Wetlands and the Forbes Creek/Juanita Bay wetlands. The effluent from these outfalls passes through dense emergent wetland areas, increasing their travel time to the lake itself and allowing the vegetation to filter pollutants. Where stormwater outfalls draining residential and urban area discharge directly to the lake, the filtration benefits of Segment B vegetation are short-circuited.
Attenuating wave energy	HIGH: The shallow Juanita Bay with some of its dense emergent and submerged vegetation areas and the very densely vegetated emergent/submerged community of the Yarrow Bay Wetlands likely attenuate boat and wind-driven waves substantially.
Sediment removal and bank stabilization	HIGH: The vegetated wetland communities of Juanita Bay/Forbes Creek and Yarrow Bay Wetlands are likely playing a major role in stabilizing their associated banks, particularly when combined with their wave attenuation function. Any sediment inputs from upland developments that pass through these areas are also likely filtered and stored. Only 7% of this segment has traditional shoreline armoring.
LWD and organic matter recruitment	MODERATE: LWD and organic matter are much more abundant in this segment than in Segments A, C and D. However, most of the material is deciduous in origin (quicker decay than coniferous species), and culverts near the downstream ends of Forbes, Juanita and Yarrow Creeks prevent movement of LWD from those riparian corridors into the lake.
Hyporheic	
Removing excess nutrients and toxic compounds	HIGH: The hyporheic zone is only slightly restricted in this segment, and likely provides excellent nutrient and toxic compound removal. No data is available on this subject.

Function	Performance
Water storage	HIGH: The hyporheic zone likely does provide water storage, although that function is of low importance in a managed lake. Quantitative data are not available.
Support of vegetation	HIGH: The hyporheic zone is likely responsible for hydrology that supports the extensive Juanita Bay/Forbes Creek wetlands and the Yarrow Bay Wetlands.
Sediment storage and maintenance of base flows	HIGH: No data is available about the characteristics of the Lake Washington hyporheic zone, but it is assumed that sediment storage could be occurring if conditions allow. There are few anthropogenic obstacles in this segment. However, neither sediment composition nor base flows are particularly important in Lake Washington.
Habitat	
Physical space and conditions for life history	HIGH: Much of Segment B contains excellent shallow-water habitat, including sandy areas preferred by juvenile chinook, and complex areas with a lot of vegetative and woody structure for other fish and aquatic life. The large emergent, scrub-shrub and forested wetland areas provide excellent habitat for mammals, birds and amphibians. Cover, food, nesting sites, travel corridors, etc. are present.
Food production and delivery	HIGH: The vegetated wetland communities of Juanita Bay/Forbes Creek and Yarrow Bay Wetlands provide abundant food for terrestrial and aquatic wildlife, and the streams passing through the wetlands likely also transport food for aquatic species into the lake.

Water quantity and water quality issues in lake environments are generally equally distributed throughout the lake, rather than being reach- or segment-specific such as may occur in stream environments with uni-directional flow. However, sheltered bays, such as those found between Hunts Point and Yarrow Point or potentially even Yarrow and Juanita Bays, may locally retain inputs more than areas that are exposed to wind- and boat-driven wave action. Although Lake Washington regularly receives inputs of nutrients (fertilizers), hydrocarbons (from in-water vehicles and road runoff), pesticides, and other pollutants, the *Final Lake Washington/Cedar/ Sammamish Watershed (WRIA 8) Chinook Salmon Conservation Plan* does not identify Lake Washington as a waterbody with degraded water quality.

Except in O.O. Denny Park and perhaps Kiwanis Park, large woody debris (LWD) recruitment potential has been virtually eliminated from Segments A, C and D in conjunction with shoreline armoring and landscaping. Scattered large trees do remain on individual properties, insufficient to develop a migratory corridor for wildlife. The property owner would likely either remove a large shoreline tree when it becomes a hazard to the residence, or would remove the tree to eliminate a safety hazard to boaters and swimmers if the tree falls into the lake. Loss of large woody debris in the nearshore area reduces a habitat component that provides cover for fish, perches for piscivorous birds, basking sites for turtles, and attachment sites for invertebrates and aquatic vegetation. Large woody debris can also affect the movement and distribution of substrate material.

There is some LWD recruitment potential remaining in O.O. Denny Park (Segment A); Juanita Bay Park, Forbes Creek riparian corridor, and Yarrow Bay Wetlands (Segment B); and Kiwanis Park (Segment C). However, most of the recruitment would be from deciduous species, such as red alder and black cottonwood, which have reduced longevity relative to Douglas-fir or western red cedar. Further, to benefit the in-water shoreline environment, large woody debris must be able to move downstream to the lake. Roads and culverts, as well as insufficient stream flows, are barriers to movement of the wood from stream corridors into the lake. Smaller organic debris (sticks, twigs, leaves, etc) that enters the streams may find their way into the lake and provide some habitat benefits.

As discussed above, shoreline armoring has extensive adverse affects on nearshore habitat (emergent and riparian vegetation, sediment recruitment and distribution, turbulence, non-native predator habitat, etc.). Approximately 67 percent of the City's shoreline (including the PAA) is armored, concentrated primarily in Segments A, C and D. In a 2001 study (Toft), the entire shoreline of Lake Washington was determined to be 70.65 percent armored, indicating that conditions within the City's jurisdiction are consistent with the average lake-wide condition. The average number of piers per mile within the City (and PAA) is 37.4; a 2001 study reported a lake-wide average of 36 piers per mile.

Except in O.O. Denny Park (Segment A), and Juanita Bay Park, Forbes Creek riparian corridor, and Yarrow Bay Wetlands (Segment B) (see discussions under Sections 4.1 and 4.2), significant wildlife habitat in shoreline jurisdiction has been eliminated. Much of the habitat was lost with the lowering of the lake elevation, but residential development close to the shoreline, with accompanying landscaping and shoreline modifications, has removed much of the remaining potential riparian habitat. Species that do utilize the upland and/or aquatic areas of Segments A, C and D include otter, muskrat, great blue heron, perching and foraging raptors, and waterfowl (including Canada geese which can produce a human health hazard and are considered a nuisance by many shoreline residents and users). Other suburban- and urban-adapted birds and mammals may also reside in these areas. Segment B and the other undeveloped parks within Segments A, C and D are utilized by a much broader range of wildlife, but are still limited by low connectivity to large patches of habitat, adjacent development, and other factors.

For comparison purposes between segments, a semi-quantitative matrix was assembled that compiles quantitative measures of shoreline condition with a relative ranking (Table 20). These relative rankings were averaged, producing a score for overall ecological function relative to the other segments in the study area. A value of 3 is the maximum and 1 is the minimum. As expected based on the qualitative discussions above, Segment B has the highest score and accordingly has the highest level of existing ecological function in the study area. Segments A and C (residential), are functioning at approximately half that level, and Segment D (urban) has a score of close to 1, indicating very low performance of ecological functions. Figure 16 graphically illustrates relative levels of ecological function with the City and the PAA.

Table 20. Semi-Quantitative Assessment of Relative Ecological Condition by Segment.

Indicator of Function		Segment: A PAA	B Yarrow Bay/ Juanita Bay	C Residential	D Urban
% Impervious	**Raw Value**	28.8	3.3	29	55.5
	Relative Ranking*	2	3	2	1
Overwater Cover/Lineal Foot of Shoreline	**Raw Value**	8.90 ft^2	1.55 ft^2	8.93 ft^2	24.13 ft^2
	Relative Ranking	2	3	2	1
# of Overwater Structures/Mile	**Raw Value**	54.9	2.5	51.9	27.2
	Relative Ranking	1	3	1	2
Average Setback	**Raw Value**	90 ft	821 ft	56 ft	35 ft
	Relative Ranking	2	3	2	1
% Armored Shoreline	**Raw Value**	76	7	83	90
	Relative Ranking	1	3	1	1
Relative Ranking Average		**1.6**	**3**	**1.6**	**1.2**

* Value of 3 is high/good, value of 1 is low/poor

5.3.2 Summary of King County's Analysis

In 2006, as a step toward updating the King County Shoreline Master Program, King County conducted a County-wide shoreline inventory and characterization that used a GIS-based "spatially explicit raster model." Each of nine processes that operate in lacustrine environments was modeled and scored, with scoring assigned as a particular process in the "pixel" (smallest evaluation unit, 25 ft^2) rated relative to all other King County lake shoreline pixels. Potential scores ranged from 0 to 4, with 0 representing "highly altered conditions" and 4 representing little or no alteration. Pixel scores were then combined at the reach scale (delineated by King County using geomorphic data only), although that level is not illustrated on King County's map product for Kirkland and the PAA.

King County ran the model for the City of Kirkland and its PAA, although the scoring is still assigned relative to all County shoreline lakes. The scores for Kirkland and the PAA for each process are shown below in Table 21. The process scores were averaged for each pixel and divided into five generalized categories of low, medium/low, medium, medium/high or high function. Maps showing the results are provided in Appendix G.

Table 21. King County Characterization Model Result for the City and the PAA.

PROCESS	Kirkland (Segments B-D)	PAA (Segment A)
Light energy	1.8	1.6
LWD	1.1	1.5
Nitrogen	3.5	3.3
Pathogens	2.9	2.9
Phosphorus	2.3	1.7
Sediment	2.2	2.3
Toxins	2.5	2.0
Hydrologic cycle	1.6	1.4
Wave energy	1.7	1.1

King County's mapping of ecological function provides a high level of detail at a small scale (nine specific lacustrine processes at 25 ft^2 pixels). However, the results are derived on model inputs that are not necessarily field verified. For King County, this is the best way to approach analyzing a large area, but it is not based on a field assessment and an intimate understanding and familiarity with the City's conditions. Of necessity, the King County model and characterization cannot reach the same level of detail as the City's characterization, considering such special topics as Juanita Bay sedimentation or localized aquatic invasive species problems. In addition, King County's mapping effort does not include the Forbes Creek riparian corridor and places the City in the context of all lakes in the County. In contrast, the City's mapping of ecological function is based upon quantitative GIS-based data that has been verified through both aerial photography (2005) and field reconnaissance efforts. The City's mapping looks at segment scales that were delineated based on biological and physical conditions, as well as zoning and other land use considerations that lend themselves to future identification of shoreline environment designations which are a foundation of the SMP regulations.

In spite of these differences, both the City's and King County's characterizations identify the Juanita Bay and Yarrow Bay areas (City Segment B) as high-functioning (see Figure 16, Table 20 and Appendix G). The two methods diverge, however, in the urban and residential portions of the City and the PAA. The King County method models small areas, while the City method looks at the entire segment as a whole and uses City GIS data and field-verified physical indicators of function. Accordingly, while both methods recognize the residential areas as having generally medium (City) or medium/low (King County) function, King County can select out smaller portions as high or low functioning. Comparing the two maps (Appendix F and Figure 16), it appears that the County's high-functioning areas within Segments A and C roughly correspond to areas with less armoring, parks, or retained pockets of vegetation that are farther removed from the lake edge.

The King County model further identifies the urban segment (Segment D) as primarily medium/low functioning (with small patches of other function categories), while the City's method identifies it as low functioning. The generally higher ranking of the urban area by King County is likely an artifact of the model's setting Kirkland within the King County lake-wide context. For example, when compared to other Lake Washington areas, such as Renton or the City of Seattle, Kirkland's urban area is not far removed in function from Kirkland's residential areas. The residential areas (Segments A and C) in King County's version also appear to have more low-functioning and high-medium/high pixels than King County's assessment of the urban area (Segment D), which is more uniformly rated as medium/low. Because the City's method looks at the City and the PAA in isolation from the rest of the lake, Segment D is more easily distinguishable from Segments A and C based on function. Table 20 above, which summarizes some key quantitative measures that indicate function by segment as determined by the City, shows that Segment D has about twice the impervious surface, triple the over-water cover, about half the structure setback, and 10 percent more shoreline armoring as Segments A/C. Although these differences may not appear significant at the County-wide lake scale, at the City scale, they are meaningful.

The scores in Table 21 indicate that the various water quality processes (nitrogen, pathogens, toxins, phosphorus) are performing relatively well (score greater than 2). The poorly performing processes, as discussed in the City's method, relate to the hydrologic cycle, light energy, wave energy, and LWD. To a large extent, these variables are strongly affected by the prevalence of shoreline armoring, over-water structures, and upland development, and the corresponding lack of shoreline vegetation.

The City's method of assessing and characterizing ecological function will be best for Kirkland's development of appropriate environment designations and the Restoration Plan because of its ability to incorporate special topics based on citizen input and unique but localized circumstances, and develop and present more qualitative information. The City is intimately familiar with conditions in the City limits and the PAA, the knowledge and value of which cannot be captured in a model. In future steps of the City's SMP update process, the City will be incorporating and utilizing more quantitative data. King County's shoreline characterization results will be a useful tool to provide additional support to the City's Restoration Plan development, including prioritization of different restoration elements. For example, a quantitative assessment tool that will be developed by the City to prioritize and evaluate restoration projects may include questions or scoring elements that link to King County's characterization results.

6.0 REPORT REFERENCES AND BIBLIOGRAPHY

Allan, R.C. and J. Romero. 1975. Underwater observations of largemouth bass spawning and survival in Lake Mead. Pages 104-112 *in* H. Clepper, ed. Black Bass Biology and Management. Sport Fishing Institute, Washington, DC. 534 p.

Arkoosh, M.R., E. Casillas, P. Huffman, E. Clemons, J. Evered, J.E. Stein, and U. Varanasi. 1998. Increased susceptibility of juvenile chinook salmon from a contaminated estuary to *Vibrio anguillarum*. Trans. Am. Fish. Soc. 127:360-374.

Arnold, Jr., C.L. and C.J. Gibbons. 1996. Impervious surface coverage: the emergence of a key environmental indicator. Journal of the American Planning Association 62(2): 243-258.

Bartoo, N.W. 1972. The vertical and horizontal distributions of northern squawfish (*Ptychocheilus oregonensis*), peamouth (*Mylocheilus caurinus*), yellow perch (*Perca flavescens*), and adult sockeye salmon (*Oncorhynchus nerka*) in Lake Washington. M.S. Thesis, Univ. of Washington, Seattle, WA. 60 p.

Bassett, C.E. 1994. Use and evaluation of fish habitat structures in lakes of the eastern United States by the USDA Forest Service. Bulletin of Marine Science 55: 1137-1148.

Booth, D. 1998. Are wild salmon runs sustainable in rehabilitated urban streams? In Abstracts from the Salmon in the City conference. Center for Urban Water Resources Management, University of Washington, Seattle, WA. 65 pp.

Booth, D.B. 2000. Forest cover, impervious-surface area, and the mitigation of urbanization impacts in King County, Washington. *Prepared for* King County Water and Land Use Division, *by* Center for Urban Water Resources Management, University of Washington, Seattle, WA. September 2000. 18 p.

Booth, D.B., D. Hartley, and R. Jackson. 2002. Forest cover, impervious surface area, and the mitigation of stormwater impacts. J. Amer. Water Res. Assoc. 38(3): 835-845.

Booth, D.B. and P.C. Henshaw. 2001. Rates of channel erosion in small urban streams. Pages 17-38 in M.S. Wigmosta and S.J. Burges, editors. Land Use and Watersheds: human influences on hydrology and geomorphology in urban and forestry areas. Water and Science Application Volume 2. Amer. Geophysical Union, Washington, DC.

Booth, D.B., J.R. Karr, S. Schauman, C.P. Konrad, S.A. Morley, M.G. Larson, and S.J. Burges. 2004. Reviving urban streams: land use, hydrology, biology, and human behavior. Journal of the American Water Resources Association 40:1351-1364.

Brown, A.M. 1998. Shoreline residential development and physical habitat influences on fish density at the lake edge of Lake Joseph, Ontario. M.S. Thesis, University of Toronto, Toronto, Ontario. 74 p.

Bryan, M.D. and D.L. Scarnecchia. 1992. Species richness, composition, and abundance of fish larvae and juveniles inhabiting natural and developed shorelines of a glacial Iowa lake. Environmental Biology of Fishes 35:329-341.

Bugert, R. M. and T. C. Bjornn. 1991. Habitat use by steelhead and coho salmon and their responses to predators and cover in laboratory streams. Trans. Am. Fish. Soc. 120: 486-493.

Christensen, D.L., B.R. Herwig, D.E. Schindler, and S.R. Carpenter. 1996. Impacts of lakeshore residential development on coarse woody debris in north temperate lakes. Ecological Applications 6:1143-1149.

Chrzastowski, M. 1983. Historical changes to Lake Washington and route of the Lake Washington Ship Canal, King County, Washington. Dept. of the Interior, U.S. Geological Survey, Water Resources Investigation, Open-File Report, WRI 81-1182.

City of Kirkland. 1989. Shoreline Master Program. City of Kirkland, Kirkland WA.

City of Kirkland. 2003. Natural Resource Management Plan. 75 pp.

City of Kirkland. 2004. City of Kirkland Comprehensive Plan.

City of Kirkland, Public Works. 2005a. City of Kirkland Surface Water Master Plan.

City of Kirkland, Parks and Community Services. 2005b. Juanita Bay Park Ranger quarterly newsletter. Winter 2005.

City of Kirkland. Capital Improvement Program 2006 to 2011.

City of Kirkland. 2006. GIS Mapping (aerial photo analysis)

City of Kirkland and King County. 2002. Habitat inventory and assessment of Juanita Creek in 2000. 47 pp.

Coble, D.W. 1975. Smallmouth bass. Pages 21-33 *in* H. Clepper, ed. Black Bass Biology and Management. Sport Fishing Institute, Washington, DC. 534 p.

Colle, D.E., R.L. Cailteux, and J.V. Shireman. 1989. Distribution of Florida largemouth bass in a lake after elimination of all submerged aquatic vegetation. N. Am. J. Fish. Manage. 9: 213-218.

Collins, N.C., P. St. Onge, V. Dodington, W. Dunlot, and N. Hutchinson. 1995. The importance to small fish of littoral fringe habitat ($Z<0.2m$) in unproductive lakes, and the impacts of shoreline development. Poster presented at the 15th Annual International Symposium of the North American Lake Management Society, 6-11 November 1995, Toronto, ON. 6 p.

Coutant, C.C. 1975. Responses of bass to natural and artificial temperature regimes. Pages 272-285 *in* H. Clepper, ed. Black Bass Biology and Management. Sport Fishing Institute, Washington, DC. 534 p.

Edmondson, W.T. 1991. The uses of Ecology: Lake Washington and Beyond. University of Washington Press, Seattle, WA.

Eggers, D.M., N.W. Bartoo, N.A. Rickard, R.E. Nelson, R.C. Wissmar, R.L. Burgner, and A.H. Devol. 1978. The Lake Washington ecosystem: the perspective from the fish community production and forage base. J. Fish. Res. Board Can. 35: 1553-1571.

Evermann, B.W. and S.E. Meek. 1897. A report upon salmon investigations in the Columbia River Basin and elsewhere on the Pacific Coast. Bulletin of the United States Fish Commission. 17: 15-84.

Fayram, A.H. and T.H. Sibley. 2000. Impact of predation by smallmouth bass on sockeye salmon in Lake Washington. N. Am. J. Fish. Manage. 20:81-89.

Federal Emergency Management Agency (FEMA). 1995. Flood Insurance Rate Map (FIRM). King County, Washington and Incorporated Areas, panel 365 of 1725.

Filan, Jason. Parks Manager, City of Kirkland Parks and Community Services Department. Personal communication, e-mail to Amy Myers (The Watershed Company), 14 November 2006.

Fresh, K.L., D. Rothaus, K.W. Mueller, and C. Waldbilig. 2003. Habitat utilization by smallmouth bass in the littoral zones of Lake Washington and Lake Union/Ship Canal. 2003 Greater Lake Washington Chinook Workshop, 2002 Update and Synthesis. January 24, 2003.

Fresh, K.L. and G. Lucchetti. 2000. Protecting and restoring the habitats of anadromous salmonids in the Lake Washington Watershed, an urbanizing ecosystem. Pages 525-544 in E.E. Knudsen, C.R. Steward, D.D. MacDonald, J.E. Williams, and D.W. Reiser (editors). Sustainable Fisheries Management: Pacific salmon. CRC Press LLC, Boca Raton.

Frodge, J.D., D.A. Marino, G.B. Pauley, and G.L. Thomas. 1995. Mortality of largemouth bass (*Micropterus salmoides*) and steelhead trout (*Oncorhynchus mykiss*) in densely vegetated littoral areas tested using *in situ* bioassay. Lake and Reserv. Manage. 11: 343-358.

Gayaldo, P.F. and K. Nelson. 2006. Preliminary results of light transmission under residential piers in Lake Washington, King County, Washington: A comparison between prisms and grating. Lake and Reserv. Manage. 22(3):245-249.

Green, J. and M.W. Trett. 1989. The fate and effects of oil in freshwater. Elsevier Science Publishers, London.

Gregory, R.S. and C.D. Levings. 1996. The effects of turbidity and vegetation on the risk of juvenile salmonids, *Oncorhynchus* spp., to predation by adult cutthroat trout, *O. clarki*. Environmental Biology of Fishes. 47: 279-285.

Haines, T.A. and R.L. Butler. 1969. Responses of yearling smallmouth bass (*Micropterus dolomieui*) to artificial shelter in a stream aquarium. J. Fish. Res. Bd. Canada 26: 21-31.

Heidinger, R.C. 1975. Life history and biology of largemouth bass. Pages 11-20 *in* H. Clepper, ed. Black Bass Biology and Management. Sport Fishing Institute, Washington, DC. 534 p.

Heritage Park Master Plan (*author unknown*)

Hobson, E.S. 1979. Interactions between piscivorous fishes and their prey. Pages 231-242 *in*: H. Clepper, ed. Predator-prey Systems in Fisheries Management. Sport Fishing Institute, Washington, DC. 504 p.

J.A. Brennan Associates, PLLC. 2006. Juanita Beach Park Master Plan Report. Prepared for City of Kirkland Parks and Community Services. 1 May 2006.

Jennings, M.J., M.A. Bozek, G.R. Hatzenbeler, E.E. Emmons, and M.D. Staggs. 1999. Cumulative effects of incremental shoreline habitat modifications on fish assemblages in north temperate lakes. N. Am. J. Fish. Manage. 19: 18-27.

Jones, J.L., T.L. Haluska, A.K. Williamson, and M.L. Erwin. 1998. Updating flood maps efficiently--Building on existing hydraulic information and modern elevation data with a GIS: U.S. Geological Survey Open-File Report 98-200, from URL http://wa.water.usgs.gov/reports/floodgis/, accessed 16 August 2006, HTML format.

Kahler T., M. Grassley, and D. Beauchamp. 2000. A Summary of the effects of bulkheads, piers, and other artificial structures and shorezone development on ESA-listed salmonids in lakes. Final Report. Prepared for City of Bellevue by The Watershed Company. 74 pp.

Kerwin, J. 2001. Salmon and steelhead habitat limiting factors report for the Cedar-Sammamish Basin (Water Resource Inventory Area 8). Washington Conservation Commission. Olympia, WA.

King County Department of Natural Resources. Basin and water quality information. http://dnr.metrokc.gov/wlr/waterres/lakes/LakeWashington.htm

King County Department of Natural Resources (DNR). 2001. Maps of salmon and trout distribution. http://dnr.metrokc.gov/WRIAS/8/fish-maps/distmap.htm

King County. 2004. King County Comprehensive Plan.

Knutson, K.L. and V.L. Naef. 1997. Management Recommendations for Washington's Priority Habitats – Riparian. Washington Department of Fish and Wildlife, Olympia, WA. 181p.

Kraai, J.E., C.R. Munger, and W.E. Whitworth. 1991. Home range, movements, and habitat utilization of smallmouth bass in Meredith Reservoir, Texas. Pages 44-48 *in* D. C. Jackson, ed. The First International Smallmouth Bass Symposium. 24-26 August 1989, Nashville, TN. Mississippi Agricultural and Forestry Experiment Station, Mississippi State Univ., Mississippi State, MS.

Lange, M. 1999. Abundance and diversity of fish in relation to littoral and shoreline features. M.S. Thesis. University of Guelph, Guelph, Ontario, Canada. 46 p. plus appendices.

Leavitt, J. 1998. The functions of riparian buffers in urban watersheds. M.S. Thesis, University of Washington, Seattle, WA. 34 pp.

Li, Kevin. *Unknown date*. The Lake Washington Story. Retrieved 16 November 2006, from King County Department of Natural Resources and Parks website. http://dnr.metrokc.gov/wlr/waterres/lakes/biolake.htm

Lucchetti, G. and R. Fuerstenberg. 1993. Management of coho salmon habitat in urbanizing landscapes of King County, Washington, USA. Pages 308-317 *in* L. Berg and P. Delaney, eds. Proc. of the 1992 coho workshop, Nanaimo, British Columbia. North Pacific International Chapter, American Fisheries Society, and Association of Professional Biologists of British Columbia, Vancouver, British Columbia.

Ludwa, K., G. Lucchetti, K. Fresh, and K Walter. 1997. Assessing stream-dwelling fish in basins of the Lake Washington watershed, summer 1996. King County Department of Natural Resources, Washington Department of Fish and Wildlife and Muckleshoot Indian Tribe.

Malcom, R. Muckleshoot Indian Tribe. Personal communication, telephone conversation with Tom Kahler (The Watershed Company), 22 November 1999.

May, C.W., R.R. Horner, J.R. Karr, B.W. Marr, and E.B. Welch. 1997a. Effects of urbanization on small streams in the Puget Sound Lowland Ecoregion. Watershed Protection Techniques 2(4): 483-494.

May, C.W., E.B. Welch, R.R. Horner, J.R. Karr, and B.W. Mar. 1997b. Quality Indices for Urbanization Effects in Puget Sound Lowland Streams. Final Report for Washington Department of Ecology, Centennial Clean Water Fund Grant No. G9400121. Department of Civil Engineering, University of Washington, Seattle, WA.

Moscrip, A.L. and D.R. Montgomery. 1997. Urbanization, flood frequency, and salmon abundance in Puget lowland streams. Journal American Water Resources Association 33(6): 1289-1297.

Nowak, G.M., R.A. Tabor, E.J. Warner, K.L. Fresh, and T.P. Quinn. 2004. Ontogenetic shifts in habitat and diet of cutthroat trout in Lake Washington, Washington. North American Journal of Fisheries Management 24:624-635.

Olney, F.E. 1975. Life history and ecology of the northern squawfish (*Ptychocheilus oregonensis* [Richardson]) in Lake Washington. M.S. Thesis, Univ. of Washington, Seattle, WA. 75 p.

Paxton, K.O. and F. Stevenson. 1979. Influence of artificial structures on angler harvest from Killdeer Reservoir, Ohio. Pages 70-76 *in* D.L. Johnson and R.A. Stein, *eds.* Response of fish to habitat structure in standing water. Special Publication 6, North Central Division, American Fisheries Society, Bethesda, MA, USA. 77 p.

Persson L. and P. Eklov. 1995. Prey refuges affecting interactions between piscivorous perch and juvenile perch and roach. Ecology 76: 70-81.

Pess, G.R., D.R. Montgomery, E.A. Steel, R.E. Bilby, B.E. Feist, and H.M. Greenberg. 2002. Landscape characteristics, land use, and coho salmon (*Oncorhynchus kisutch*) abundance, Snohomish River, Washington State, USA. Canadian Journal of Fisheries and Aquatic Sciences 59: 613-623.

Pflug, D.E. 1981. Smallmouth bass (*Micropterus dolomieui*) of Lake Sammamish: a study of their age and growth, food and feeding habits, population size, movement and homing tendencies, and comparative interactions with largemouth bass. M.S. Thesis, Univ. of Washington, Seattle, WA. 80 p.

Pflug, D.E. and G.B. Pauley. 1984. Biology of smallmouth bass (*Micropterus dolomieui*) in Lake Sammamish, Washington. Northwest Science 58: 118-130.

Poe, T.P., C.O. Hatcher, C.L. Brown, and D.W. Schlosser. 1986. Comparison of species composition and richness of fish assemblages in altered and unaltered littoral habitats. J. Freshwat. Ecol. 3: 525-536.

Puget Sound Council of Government (PSCOG). 1981.

Reinhardt, U.G. and M.C. Healey. 1997. Size-dependent foraging behavior and use of cover in juvenile coho salmon under predation risk. Can. J. Zool. 75: 1642-1651.

Ruggerone, G.T. 1986. Consumption of migrating juvenile salmonids by gulls foraging below a Columbia River dam. Trans. Am. Fish. Soc. 115: 736-742.

Schmude, K.L., M.J. Jennings, K.J. Otis, and R.R. Piette. 1998. Effects of habitat complexity on macroinvertebrate colonization of artificial substrates in north temperate lakes. J. N. Am. Benthol. Soc. 17: 73-80.

Seiler, D., G. Volkhardt, and L. Fleischer. 2005. Evaluation of downstream migrant salmon production in 2004 from the Cedar River and Bear Creek. Washington Department of Fish and Wildlife, Olympia, Washington.

Sheldon & Associates, Inc. 2004. Juanita Bay Park Vegetation Management Plan. Prepared for City of Kirkland Department of Parks and Community Services.

Sollitto, Teresa. Park Project Coordinator, Kirkland Parks and Community Services Department. Personal communication, electronic mail to Patrice Tovar (City of Kirkland), 18 August 2006.

Stein, J.N. 1970. A study of the largemouth bass population in Lake Washington. M.S. Thesis, Univ. of Washington, Seattle, WA. 69 p.

Tabor, R.A., G. Brown, and V.T. Luting. 1998. The effects of light intensity on predation of sockeye fry by prickly sculpin and torrent sculpin. May 1998. Region 1, U.S. Fish and Wildlife Service, Western Washington Office, Aquatic Resources Division, Lacey, Washington. 16 p.

Tabor, R.A., M.T. Celedonia, F. Mejia, R.M. Piaskowski, D.L.Low, B. Footen, and L. Park. 2004a. Predation of juvenile chinook salmon by predatory fishes in three areas of the Lake Washington basin. Miscellaneous report. U.S. Fish and Wildlife Service, Western Washington Fish and Wildlife Office, Lacey, Washington.

Tabor, R.A. and W.A. Wurtsbaugh. 1991. Predation risk and the importance of cover for juvenile rainbow trout in lentic systems. Trans. Am. Fish. Soc. 120: 728-738.

Tabor, R.A. and R.M. Piaskowski. 2002. Nearshore habitat use by juvenile chinook salmon in lentic systems of the Lake Washington Basin, Annual Report, 2001. U.S. Fish and Wildlife Service, Lacey, WA.

Tabor, R.A., H.A. Gearns, C.M. McCoy III, and S. Camacho. 2006. Nearshore habitat use by juvenile chinook salmon in lentic systems of the Lake Washington Basin, Annual Report, 2003 and 2004. U.S. Fish and Wildlife Service, Lacey, WA.

Tabor, R.A., J.A. Schuerer, H.A. Gearns, and E.P. Bixler. 2004b. Nearshore habitat use by juvenile chinook salmon in lentic systems of the Lake Washington basin, annual report, 2002. U.S. Fish and Wildlife Service, Western Washington Fish and Wildlife Office, Lacey, Washington.

Tetra Tech ISG, Inc. and Parametrix, Inc. 2003. Lake Washington Existing Conditions Report. Prepare for King County Department of Natural Resources and Parks. 101 pp. + appendices.

The Watershed Company. 2006. Field inventory. March 2006. (armoring, boatlifts, canopies)

The Watershed Company. 1998. Kirkland's Streams, Wetlands and Wildlife Study. *Prepared for:* Planning and Community Development, City of Kirkland, Kirkland Washington, *by:* The Watershed Company, Kirkland Washington. 86 pp. plus appendices.

Toft, J.D. 2001. Shoreline and dock modifications in Lake Washington. Prepared for King County Department of Natural Resources. October 2001. SAFS-UW-0106

Vogele, L.E. and W.C. Rainwater. 1975. Use of brush shelters as cover by spawning black basses (*Micropterus*) in Bull Shoals Reservoir. Trans. Am. Fish. Soc. 104: 264-269.

Wakeham, S.G. 1977. Hydrocarbon budgets for Lake Washington. Limnology and Oceanography 22:952-957.

Wang, L., J. Lyons, and P. Kanehl. 2003. Impacts of urban land cover on trout streams in Wisconsin and Minnesota. Trans. Amer. Fish. Soc. 132: 825-839.

Washington Department of Ecology (Ecology). 2006. Aquatic Plant and Algae Management General Permit. National Pollutant Discharge Elimination System (NPDES) and State Waste Discharge General Permit. Permit number WAG-994000. Effective 1 April 2006 – 1 April 2011. Washington Department of Ecology.

Washington Department of Ecology (Ecology) and Washington State Department of Agriculture. 2004. Integrated Pest Management Plan for Freshwater Emergent Noxious and Quarantine Listed Weeds. Revised July 2004.

Washington Department of Fish and Wildlife (WDFW). 1997. Aquatic Plants and Fish. Publication number APF-11-97.

Washington Department of Fish and Wildlife (WDFW). 1998. 1998 Washington salmonid stock inventory appendix: bull trout and Dolly Varden. 437 p.

Washington Department of Fish and Wildlife (WDFW). 2001. Aquatic Nuisance Species Management Plan. Coordinated by Pamala Meacham of the Washington Department of Fish and Wildlife for The Washington Aquatic Nuisance Species Coordinating Committee. October 2001.

Washington Department of Fish and Wildlife (WDFW). 2006. Priority Habitats and Species database search results prepared for The Watershed Company, 17 March 2006.

Washington Department of Fisheries (WDF), Washington Department of Wildlife, and Western Washington Treaty Indian Tribes. 1993. 1992 Washington State salmon and steelhead stock inventory. March 1993. Olympia, WA. 212 p.

Weaver, M.J., J.J. Magnuson, and M.K. Clayton. 1997. Distribution of littoral zone fishes in structurally complex macrophytes. Canadian Journal of Fisheries and Aquatic Sciences 54:2277-2289.

Werner E.E. and D.J. Hall. 1988. Ontogenetic habitat shifts in bluegill: the foraging rate-predation risk tradeoff. Ecology 69: 1352-1366.

Williams, R.W., R.M. Laramie, and J.J. Ames. 1975. A Catalog of Washington Streams and Salmon Utilization, Vol. 1, Puget Sound Region. Washington Department of Fisheries.

Wood, C.C. and C.M. Hand. 1985. Food-searching behavior of the common merganser (*Mergus merganser*). I: functional responses to prey and predator density. Can. J. Zool. 63: 1260-1270.

WRIA 8 Steering Committee. 2002. Lake Washington/Cedar/Sammamish Watershed (WRIA) Near-Term Action Agenda For Salmon Habitat Conservation. August, 2002. http://dnr.metrokc.gov/wrias/8/near-term-action-agenda.htm

WRIA 8 Steering Committee. 2005. Final Lake Washington/Cedar/Sammamish Watershed (WRIA 8) Chinook Salmon Conservation Plan. July 2005.

7.0 LIST OF ACRONYMS and ABBREVIATIONS

CAO ....City of Kirkland Critical Areas Ordinance

Corps..........................U.S. Army Corps of Engineers

Ecology ....Washington Department of Ecology

GMA ....Growth Management Act

HPA............................Hydraulic Project Approval

KZC............................Kirkland Zoning Code

LWD ....Large Woody Debris

NOAA Fisheries.........National Marine Fisheries Service

NRCS ....Natural Resources Conservation Service

PAA............................Potential Annexation Area

PAHs..........................polycyclic aromatic hydrocarbons

PCBs ....polychlorinated biphenyls

PHS ....Priority Habitats and Species

SMA...........................Shoreline Management Act

SMP............................Shoreline Master Program

USFWS ......................U.S. Fish and Wildlife Service

WDFW.......................Washington Department of Fish and Wildlife

APPENDIX A

INFORMATION REQUEST LETTER AND DISTRIBUTION LIST

April 14, 2006

Name
Address
Address

RE: Lake Washington Shoreline Inventory and Assessment, request for existing information

Dear Stakeholders:

The City of Kirkland is in the early stages of examining its Lake Washington Shoreline for the purposes of updating its Shoreline Master Program per requirements of the Washington State Department of Ecology. We have recently hired The Watershed Company to assist with Shoreline characterization, analysis, and regulatory review. A Shoreline inventory, conducted by biologists from The Watershed Company, will be the first step. The products of the inventory include a map portfolio and a report characterizing ecological functions and ecosystem-wide process, among other things.

The City is requesting your help in obtaining all existing physical and biological information regarding Lake Washington, associated riparian and wetland areas, and other water systems that eventually drain into Lake Washington within the City of Kirkland and its Potential Annexation Area (PAA) (see attached map). We are interested in any and all inventories, assessments, water quality analyses, and/or fish and wildlife distribution and habitat information. The TRS coordinates of the City and its PPA are: T25N, R5E, Sections 4/5/6/7/8/9/16/17/18/19/20/21; T26N, R5E, Sections 19/20/21/22/27/28/29/30/31/32/33/34; T26N, R4E, Sections 23/24/25/26/36.

We are hoping to assemble our characterization by early June 2006 in order to complete the necessary analysis and resultant recommendations in a timely manner. Because we are hoping to reduce redundant data collection at the field level, a response would be appreciated by May 15, 2006. If possible, please provide hard copies or electronic files of any studies instead of a list of citations; contact the City if a copy fee is required. If you believe that another individual within your organization would be a more appropriate contact for this solicitation, please forward this letter to that individual, and notify us of the change in contact.

If you have any questions or need additional information, please feel free to contact Patrice Tovar, Senior Planner, at (425) 587-3259 or PTovar@ci.kirkland.wa.us

Sincerely,

Patrice Tovar

Patrice Tovar, AICP, Senior Planner

123 Fifth Avenue

Kirkland, WA 98020

Enclosure: Map of Kirkland and Potential Annexation Area

Distribution List for City of Kirkland Shoreline Master Program Inventory

King County Department of Natural Resources and Parks,
Water and Land Resources Division
201 S. Jackson Street, Suite 600
Seattle, WA 98104
Phone: (206) 296-6519

Muckleshoot Indian Tribe
Attn: Karen Walters
39015 - 172nd Avenue Southeast
Auburn, WA 98092
(253) 939-3311

U.S. EPA Region 10
1200 6th Avenue
Seattle, WA 98101
(206) 553-1200

Washington Department of Fish and Wildlife
Attn: Stewart Rheinbold
16018 Mill Creek Boulevard
Mill Creek, WA 98012-1296

Lori Guggenmos
Washington Department of Fish and Wildlife
Priority Habitats and Species Program
600 Capitol Way North
Olympia, Washington 98501-1091

Washington Department of Natural Resources
Sandy Swope Moody
Natural Heritage Program
PO Box 47014
Olympia WA 98504-7014
(360) 902-1667

National Marine Fisheries Service
Attn: Tom Sibley
7600 Sand Point Way NE
Seattle, WA 98115
(360) 753-9530
Thomas.Sibley@noaa.gov

U.S. Fish and Wildlife Service
Attn: Roger Tabor
510 Desmond Drive, Suite 102
Lacey, WA 98503-1263
(360) 753-9541
roger_tabor@fws.gov

Mid Puget Sound Fisheries Enhancement Group
Attn: Troy Fields, Executive Director
7400 Sand Point Way NE, Suite 202N -
Seattle, WA 98115
(206) 529-9467
troy@midsoundfisheries.org

University of Washington
School of Aquatic & Fishery Sciences
Attn: Si Simenstad
Box 357980
Seattle, WA 98195
simenstd@u.washington.edu

King Conservation District
935 Powell Ave SW
Renton, WA 98055
(425) 277-5581
district@kingcd.org

U.S. Army Corps of Engineers
Seattle District
P.O. Box 3755
Seattle, WA 98124-3755

Washington Department of Natural Resources
Aquatic Lands and Resources Program
1111 Washington St. SE, MS: 47027
Olympia, WA 98504-7027
(360) 902-1100

Washington State Department of Natural Resources
Attn: Boyd Powers, External SEPA Coordinator
PO Box 47015
Olympia, WA 98504-7015
(360) 902.1166
Boyd.powers@wadnr.gov

East Lake Washington Audubon Society
PO Box 3115
Kirkland, WA 98083-3115

APPENDIX B

ASSESSMENT OF SHORELINE STATUS OF FORBES LAKE AND TOTEM LAKE

The Watershed Company

15 February 2006

Patrice Tovar
City of Kirkland Planning and Community Development
123 Fifth Avenue
Kirkland, WA 98033

Re: Shoreline boundary and associated wetlands

Dear Patrice:

We are pleased to present our shoreline jurisdiction findings in support of our work on the Shoreline Master Program (SMP) Update. Enclosed please find the following supporting maps:

1) The 1986 Shoreline Environments and Jurisdiction map.
2) Our revised map showing the updated shoreline jurisdiction, including associated wetlands.
3) Analysis maps of both Forbes and Totem Lakes – two significant areas in the City that we have determined are outside shoreline jurisdiction.

This letter summarizes the changes from the 1986 SMP maps and outlines our rationale for not including the two smaller lakes.

Methods

The first step in updating the map of shoreline jurisdiction was to review the precise shoreline and associated wetlands definitions found in the WAC and in Washington Department of Ecology's rules and guidance documents. Portions of these definitions that apply to the City of Kirkland revolve around the size threshold for waterbodies meeting Shoreline criteria, the State Ordinary High Water Mark (OHWM) definition, and when to consider critical areas (wetlands) as "associated" with the shoreline.

The minimum size limit for lakes to be designated as shoreline is 20 acres. Thus, as in the original SMP work, Lake Washington is identified as the main shoreline in the City. The OHWM of the lake was reviewed for accuracy. A few questionable areas were field checked to the extent access was possible from public property and rights–of-way.

Existing wetland inventory information was reviewed to identify associated wetlands. Two wetlands, Forbes Creek and Yarrow Bay, were inventoried within the 200-foot Shoreland Zone. These areas were field-checked to determine that the inventory presents a reasonably accurate representation of the true wetland boundaries.

Ecology guidance states that the entire wetland is associated if any part of it lies within the area 200 feet from the OHWM (or floodway in riverine environments) of a state shoreline. Further guidance states that wetlands that are hydraulically connected to a Shoreline also would be considered associated. Wetlands that are separated by an obvious topographic break from the shoreline are not associated, provided they are outside the shoreland zone and provided that the break is not an artificial feature such as a berm or road.

Aside from Lake Washington, the only other significant waterbodies in the City are Forbes Lake and Totem Lake. Both lakes were measured for size to determine if they exceeded the threshold. Since Forbes Lake has a well-defined OHWM, the analysis for it was done solely though aerial photograph interpretation and GIS mapping software.

Totem Lake has much more gradual topography, therefore the OHWM was field-checked and mapped onto aerials using GIS software. Interpretation of the OHWM was based on Ecology guidance provided through their Coastal Training Program.

Findings

The following changes were made to the SMP maps, subject to acceptance by Ecology. It should be noted that few, if any, private properties will be affected by these changes in terms of shoreline regulation.

Revisions to the OHWM of Lake Washington

1) Minor changes to rectify mapping errors at the mouths of Juanita Creek and Yarrow Bay Creek.
2) Minor changes along some shoreline properties based on latest aerial photographs and known conditions.
3) Added Lake Washington OHWM mapping within the City's Potential Annexation Area (Juanita Bay Park to St. Edwards State Park) using aerial photographs and topography.

Jurisdictional Boundary Changes

1) The Shoreland Zone line was added 200 feet from the revised OHWM.
2) The Shoreland Zone line was adjusted where associated wetlands were verified.
3) The boundary of the Yarrow Bay wetland was refined based on newer inventory data and limited ground-truthing.
4) The extent of the associated wetland at Forbes Creek was significantly extended based on newer inventory data and limited ground-truthing. The 1986 map shows the Forbes Creek associated wetland extending across 98th Avenue NE and the sewer line easement. This represents a distance of only about 1,800 feet southeast of the Lake Washington OHWM. The actual wetland is mapped in the inventory as extending nearly 1 mile southeast and east. The inventory mapping was field-verified as part of this study. The wetland is associated with Forbes Creek and is contained within a broad valley that slopes gently up from the lakeshore. Thus, the wetland is hydraulically connected to Lake Washington by Forbes Creek; it is also hydraulically connected by groundwater. There is no distinct topographic break between any part of the mapped wetland and the lake.

The wetland is crossed in three places: 1) 98th Avenue NE, a major arterial road; 2) a sanitary sewer line; and 3) 108th Avenue NE, a small residential street. However, these crossings are artificial features and do not serve as breaks in the jurisdictional status.

Forbes Lake and Totem Lake

Based on the updated mapping, the OHWM of Forbes Lake contains an area that is approximately 6.60 acres. This size remains unchanged from prior City mapping. This is well below the 20-acre threshold for shoreline jurisdiction.

Current City maps show Totem Lake as being 3.29 acres. This is based on the area of open water visible in aerial photographs. Because the lakeshore of Totem Lake is so gradual, there are large areas of emergent vegetation growing in shallowly ponded areas. Field observation revealed that the actual extent of standing water extends well beyond what is visible open water in the aerials. The area contained within the OWHM as verified in the field and as mapped using aerial photos and topography is 18.98 acres. This size is still more than 1 acre smaller than the 20-acre threshold for shoreline jurisdiction. In some instances, jurisdictions have, at their option, decided to place areas near the 20-acre limit within the shoreline jurisdiction. However, we do not expect that mapping error is significant enough to add an entire acre to the overall size. Further, the lake is owned by King Conservation District, officially designated by the City of Kirkland as a Park/Public Use Zone, and is protected under the City's critical areas regulations, which were updated in 2002 pursuant to the GMA. Therefore, we recommend that Totem Lake not be designated as a Shoreline.

Once the revised mapping has been reviewed by the City, it will be ready for review by Ecology. After receiving Ecology's approval, the final shoreline jurisdiction GIS layer will be provided to Xiaoning Jiang, the City's GIS Administrator, to serve as the foundation for the remaining map products required by Ecology as part of the SMP Update.

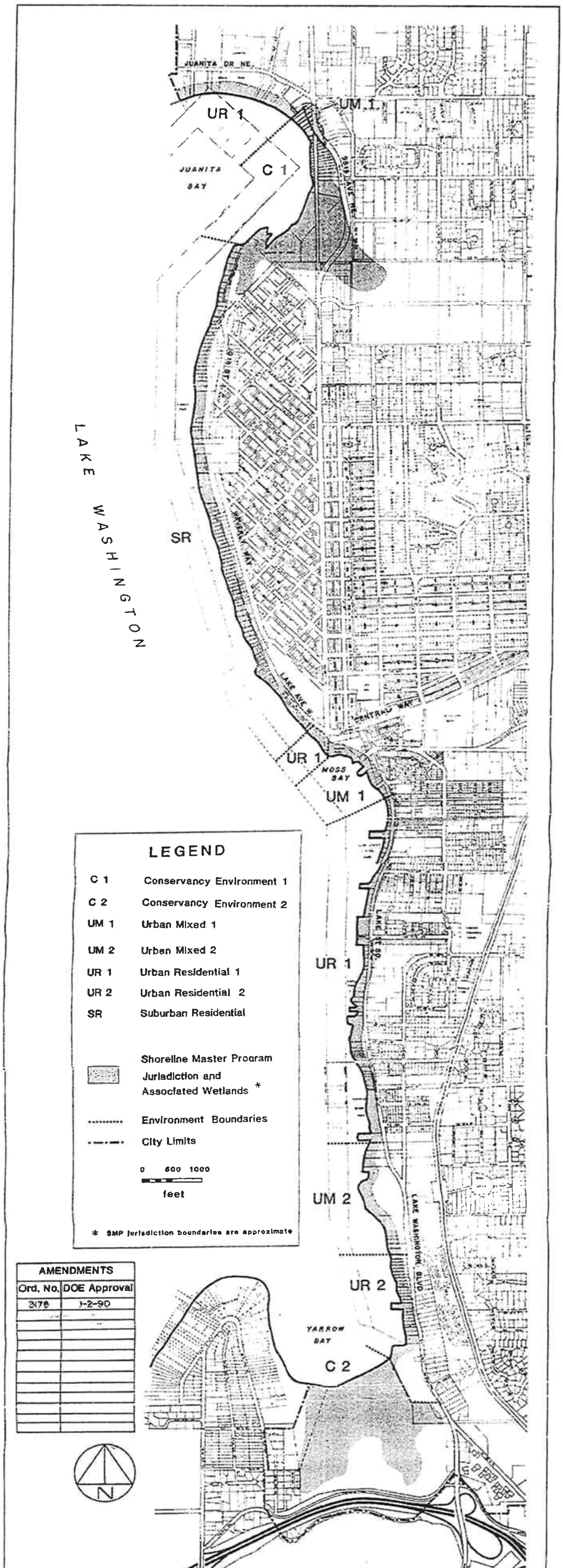
Please call if you have any questions.

Sincerely,

for Amy Myers

Hugh Mortensen
Ecologist/PWS

Enclosures



AMENDMENTS	
Ord. No.	DOE Approval
3176	1-2-90

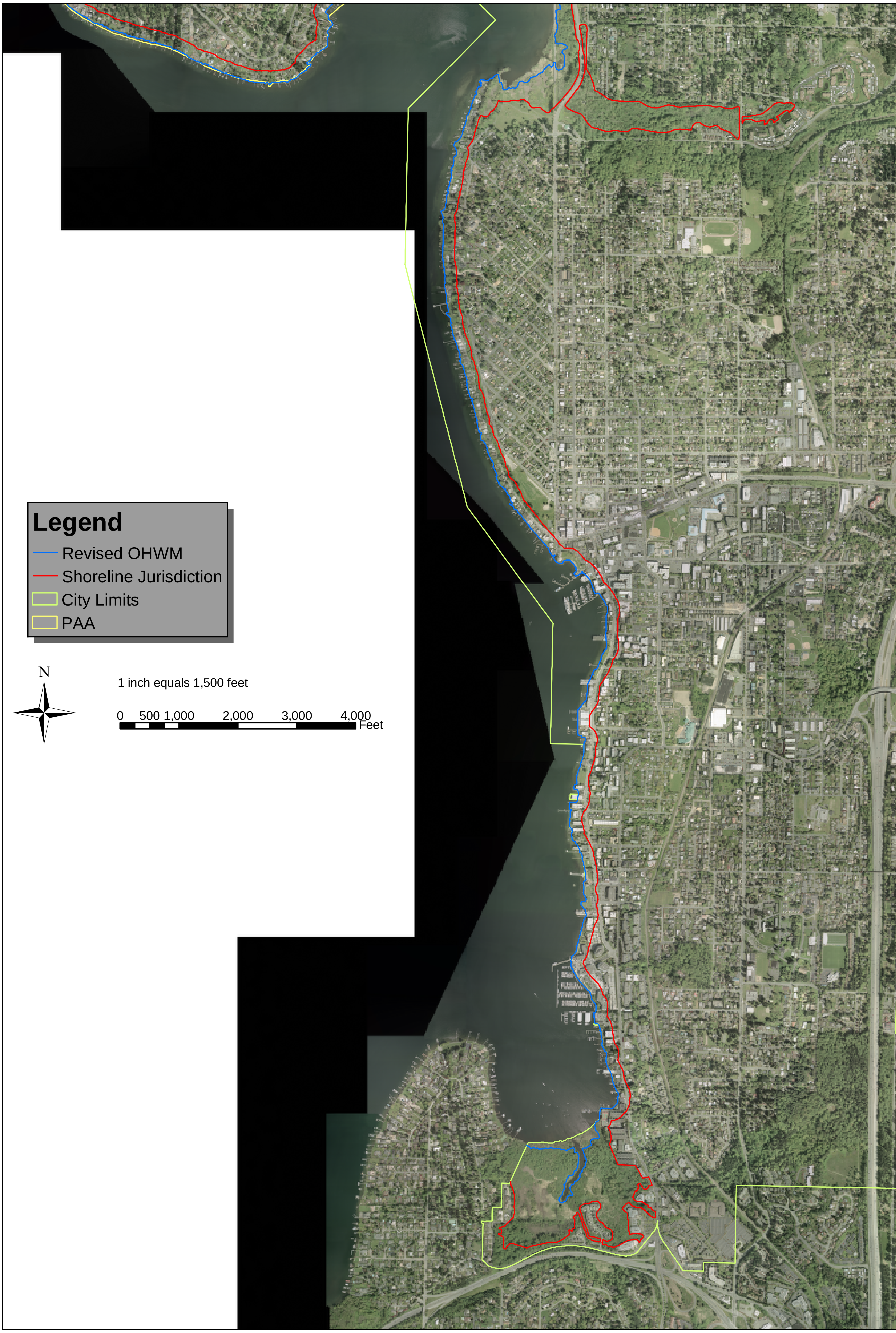
City of Kirkland

February, 1986 (Ordinence 2938)

SHORELINE ENVIRONMENTS AND JURISDICTION

City of Kirkland and Potential Annexation Area
Shoreline Jurisdiction Determination: North
February 2006

City of Kirkland and Potential Annexation Area
Shoreline Jurisdiction Determination: South
February 2006



Forbes Lake: 6.60 acres at OHWM

1 inch equals 150 feet

0 37.5 75 150 225 300 Feet

N

Totem Lake: 18.98 acres at OHWM

N

1 inch equals 150 feet

0 37.5 75 150 225 300 Feet

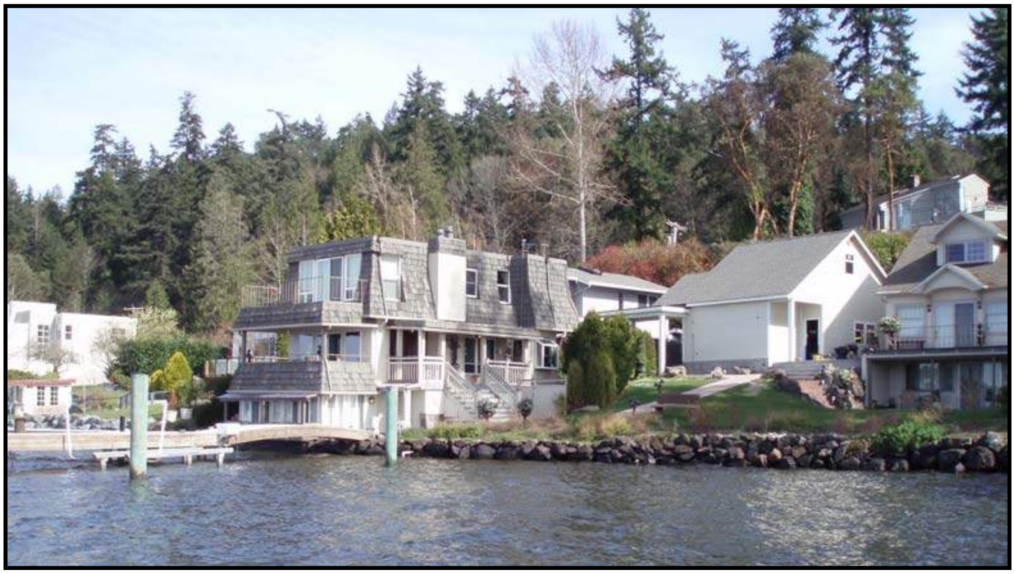
APPENDIX C

PHOTOGRAPHS

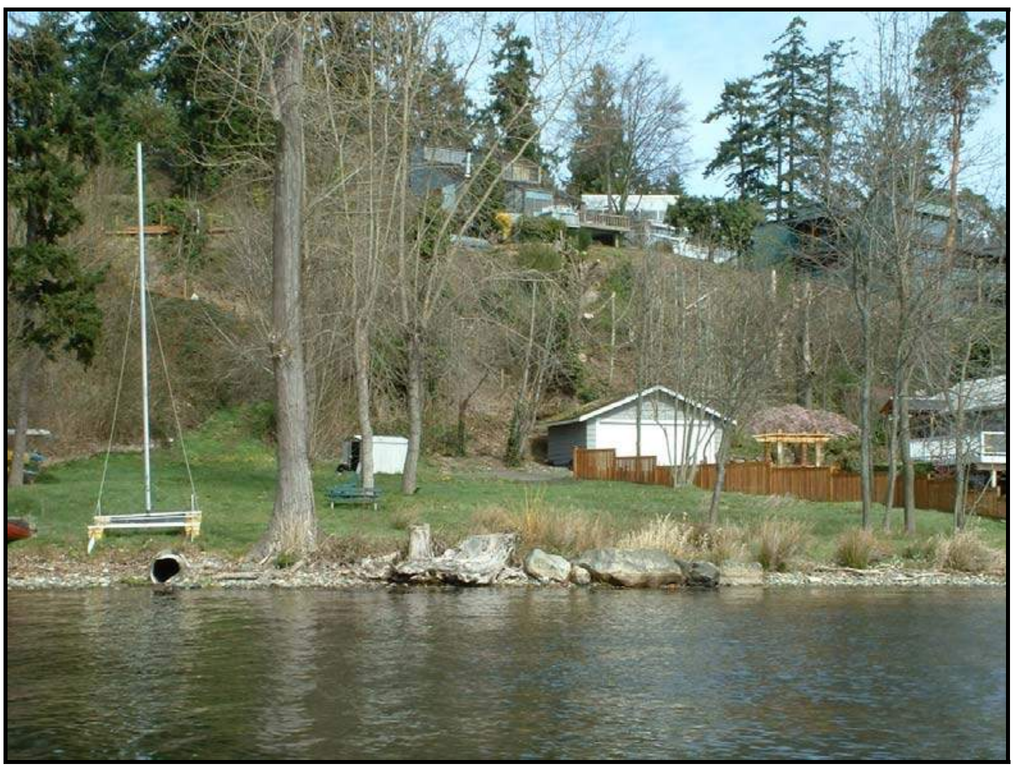
Segment A - PAA

North end of Segment A (PAA), St. Edwards State Park is to the left. Note juxtaposition of native conditions (no armoring, large woody debris, native riparian vegetation) with typical residential condition (bulkhead, pier, lawn with no vegetation overhanging water, no woody debris)

O.O. Denny Park.



Typical boulder bulkhead.



Semi-natural shoreline (emergent vegetation, scattered boulders and gravel beach)

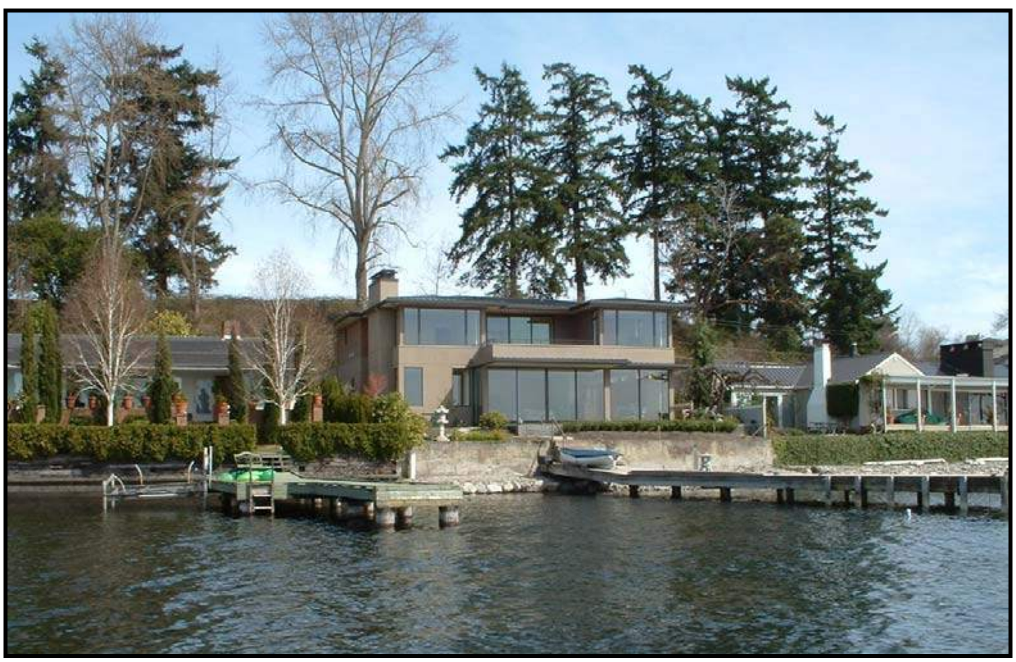
Segment B – Juanita and Yarrow Bays

Juanita Bay – note abandoned piles, nearshore raised boardwalk and abundant shoreline vegetation

Yarrow Bay Wetlands

Segment C – Residential

Waverly Park



Typical shoreline

Segment D – Urban

Kirkland Yacht Club – new breakwater.

Concrete bulkhead in City park..

Carillon Point.

Over-water condominium.

APPENDIX D

EXAMPLE OF PUBLIC ACCESS EASEMENT AGREEMENT

DEDICATION OF PUBLIC ACCESS EASEMENT AREA ON PRIVATELY OWNED SHORELINE

The undersigned persons, hereinafter referred to as "dedicator" and being all of the owners of the real property hereinafter described, do hereby make in perpetuity for the use of the general public, in a manner consistent herewith, the following easement dedication:

1. AREA TO BE DEDICATED

The area hereby dedicated is described in Exhibit A attached hereto and made a part hereof as though fully set forth herein.

2. PURPOSE OF DEDICATION

The real property herein described is dedicated to the City of Kirkland on behalf of the general public in order to allow pedestrian access and entry onto the dedicated area by the general public and all members thereof for the peaceful enjoyment of the dedicated area and the waters of Lake Washington adjoining. Dedicator reserves all rights and uses in and to the public access area which are not repugnant to the uses herein granted.

3. LIMITATION ON DEDICATION

The rights of the general public and all members thereof, granted herein, are subject to the following limitations:

(a) Access to the dedicated area by land vehicle or watercraft is specifically excluded from this dedication. Access by land vehicle or watercraft shall be upon specific invitation of the dedicator only.

(b) The entire dedicated area may be closed to public access by the dedicator each day from dusk to 10 a.m., of the following day.

(c) All or any portion of the dedicated area may be temporarily closed to the public from time to time for the purpose of repairs and maintenance.

(d) Pursuant to RCW 4.24.210, neither the dedicator, nor the City of Kirkland, nor the State of Washington, nor the officers, agents, employees of said City and State shall be responsible or held liable for injury or damage occurring to members of the general public availing themselves of the dedicated area, unless the injury or damage results from an immediate, direct, and negligent act of the party sought to be held, and in no event shall the dedicator, the City of Kirkland, or the State of Washington be responsible for any act or omission of a third party, or be responsible for the failure to provide security, supervision, or guards for members of the general public or to provide protection for the general public for acts or omissions of other members of the general public.

(e) The dedicator shall have the sole and separate responsibility of maintaining any portion of the dedicated area to which the general public shall have access and shall defend and save harmless the City of Kirkland and the State of Washington, including their officers, agents, and employees from any claims real or imaginary asserted by any person for injury or damages resulting from improper maintenance of said dedicated area. The standard of maintenance shall be equal to the standards of maintenance practiced by the City of Kirkland in regard to its waterfront parks. This covenant of maintenance and to defend and save harmless the City of Kirkland and the State of Washington shall run with the land. Copies of all conveyances by dedicator and its subsequent grantees conveying individual apartment units to apartment owners and/or interests therein to any association of apartment or condominium owners shall be recorded with the King County Department of Records and Elections and shall be filed with the City of Kirkland. The word, apartment, as used herein includes the word, "condominium."

(f) Nothing in this dedication shall operate or be held to relieve the dedicator from the continuing requirements and conditions imposed by the permits issued to the dedicator under City of Kirkland File(s) No. ____________________.

(g) Dedicator shall install and maintain, at such locations within or adjoining the dedicated property as may be designated by the City of Kirkland, "public access" signs meeting the standards for such signs established and adopted by the City of Kirkland. <u>No other signs referring to public access or to the dedicated property shall be installed without prior written approval of the City of Kirkland</u>.

4. <u>AUTHORITY OF DEDICATOR</u>

Dedicator warrants to the City of Kirkland that dedicator's ownership interest in the real property described herein includes the full power to enter into agreement and/or covenants which will run with the land and bind all owners of said property, their heirs, successors, and assigns.

5. <u>DEFINITIONS</u>

As used herein:

(a) The word, "dedicator," shall include the heirs, successors, and assigns thereof;

(b) The words, "land vehicle," shall include motor vehicles, bicycles, skateboards, and other vehicles designed to operate upon land whether self-propelled or not; provided that "land vehicle" shall not include a wheelchair or similar device whether or not self-propelled when used by individuals with disabilities.

6. <u>RECORDING</u>

This dedication document shall be recorded in the Department of Records and Elections for King County and shall further be included by inclusion or reference in any condominium documents that may hereafter be required to be recorded.

DATED this __________ day of ____________________, ________.

(Sign in blue ink)

(***Individuals Only***)

OWNER(S) OF REAL PROPERTY (INCLUDING SPOUSE)

____

____

____

(***Individuals Only***)

STATE OF WASHINGTON)
) SS.
County of King)

On this _____ day of ____________, _____, before me, the undersigned, a Notary Public in and for the State of Washington, duly commissioned and sworn, personally appeared ____ and ____ to me known to be the individual(s) described herein and who executed the Dedication of Public Access Easement Area on Privately Owned Shoreline and acknowledged that ______________________________ signed the same as ______________________________ free and voluntary act and deed, for the uses and purposes therein mentioned.

WITNESS my hand and official seal hereto affixed the day and year first above written.

____

Notary's Signature

____

Print Notary's Name
Notary Public in and for the State of Washington, Residing at: ____________

My commission expires: ____________________

(Partnerships Only)

OWNER(S) OF REAL PROPERTY

____

(Name of Partnership or Joint Venture)

____

By General Partner

____

By General Partner

____

By General Partner

(Partnerships Only)

STATE OF WASHINGTON)
) SS.
County of King)

On this ______ day of ______________, ______, before me, the undersigned, a Notary Public in and for the State of Washington, duly commissioned and sworn, personally appeared ____ and ____ to me known to be the individual(s) described herein and who executed the Dedication of Public Access Easement Area on Privately Owned Shoreline and acknowledged that ________________________________ signed the same as ________________________________ free and voluntary act and deed, for the uses and purposes therein mentioned.

WITNESS my hand and official seal hereto affixed the day and year first above written.

____

Notary's Signature

____

Print Notary's Name
Notary Public in and for the State of Washington, Residing at: ______________

My commission expires: ________________

(Corporations Only)

OWNER(S) OF REAL PROPERTY

____

(Name of Corporation)

____

By President

____

By Secretary

(Corporations Only)

STATE OF WASHINGTON)
) SS.
County of King)

On this _____ day of ____________, _____, before me, the undersigned, a Notary Public in and for the State of Washington, duly commissioned and sworn, personally appeared ______________________________________ and ______________________________________ to me known to be the representative of ____________________________ corporation that executed the Dedication of Public Access Easement Area on Privately Owned Shoreline and acknowledged the said instrument to be the free and voluntary act and deed of said corporation, for the uses and purposes therein set forth, and on oath stated that they were authorized to sign said instrument and that the seal affixed is the corporate seal of said corporation.

WITNESS my hand and official seal hereto affixed the day and year first above written.

____

Notary's Signature

____

Print Notary's Name

Notary Public in and for the State of Washington, Residing at: ______________

My commission expires: ______________

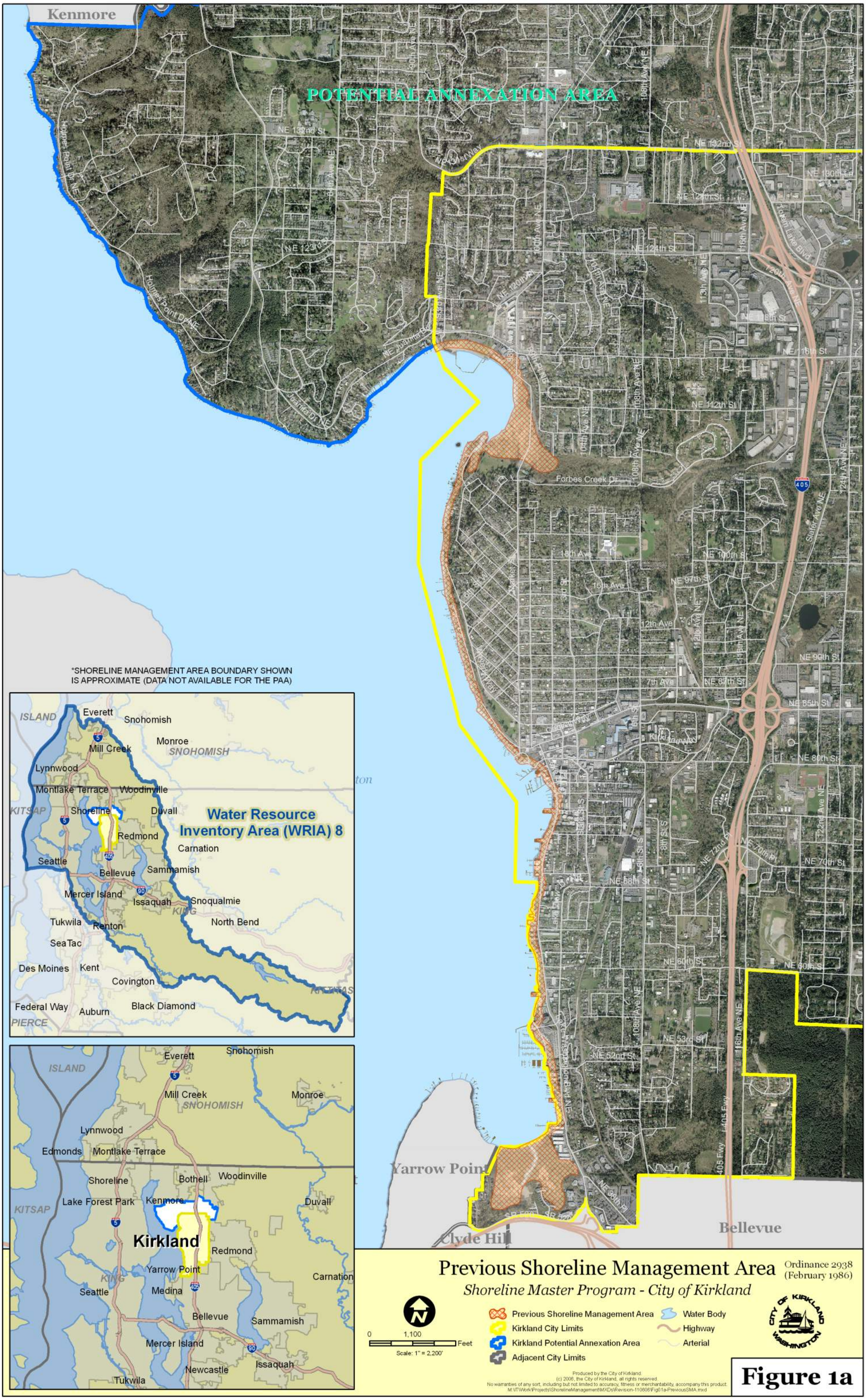
The foregoing Agreement is accepted by the City of Kirkland this ______ day of ________________________, ________.

CITY OF KIRKLAND

BY: ______________________

APPENDIX E

MAP FOLIO

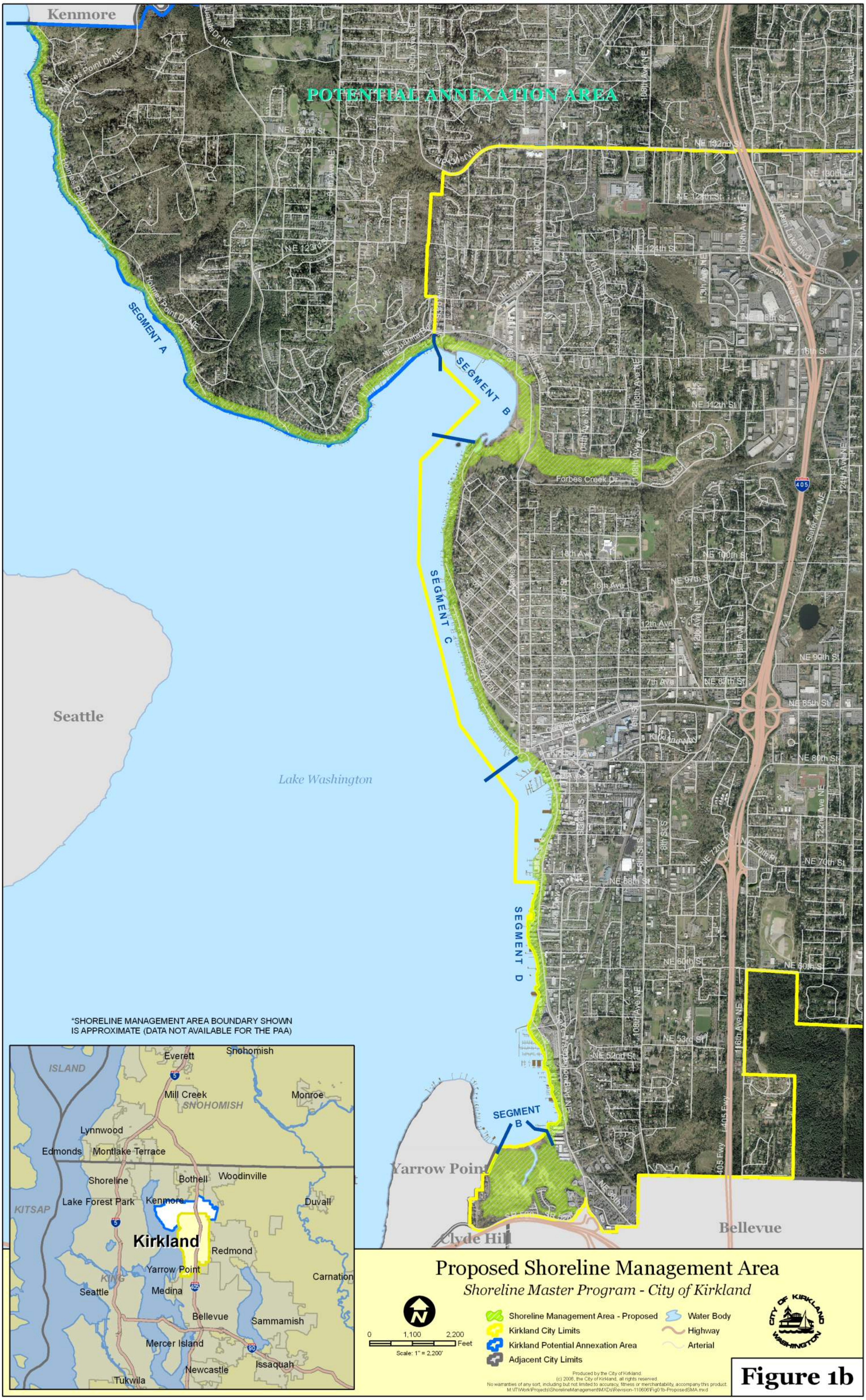


Previous Shoreline Management Area

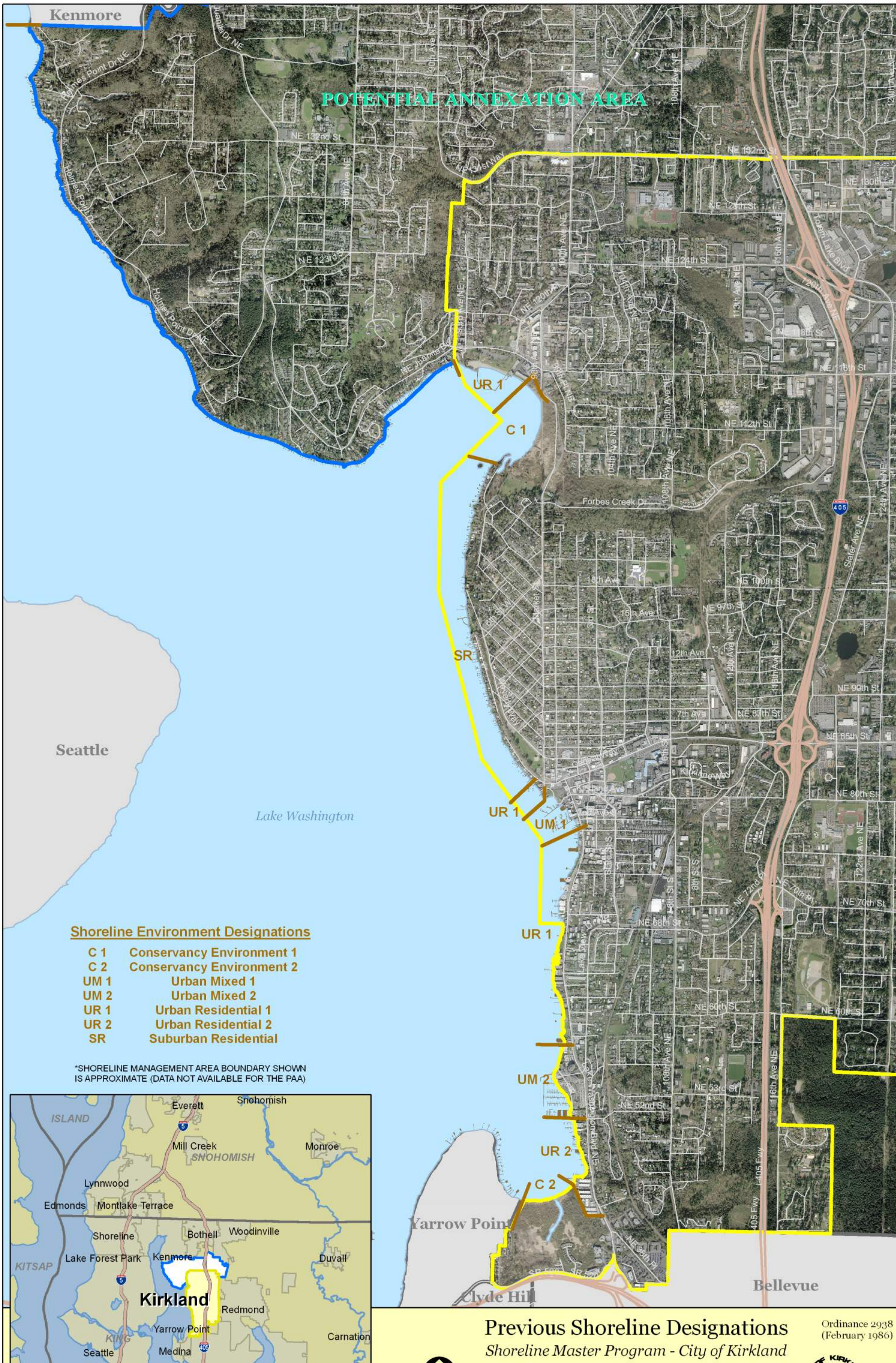
Ordinance 2938 (February 1986)

Shoreline Master Program - City of Kirkland

Figure 1a



Kenmore
POTENTIAL ANNEXATION AREA
SEGMENT A
SEGMENT B
SEGMENT C
SEGMENT D
SEGMENT B
Seattle
Lake Washington
Yarrow Point
Clyde Hill
Bellevue
NE 132nd St
NE 124th St
NE 116th St
NE 112th St
NE 85th St
NE 80th St
NE 70th St
Forbes Creek Dr
*SHORELINE MANAGEMENT AREA BOUNDARY SHOWN IS APPROXIMATE (DATA NOT AVAILABLE FOR THE PAA)
ISLAND
Everett
Snohomish
Mill Creek
SNOHOMISH
Monroe
Lynnwood
Edmonds
Montlake Terrace
Shoreline
Bothell
Woodinville
KITSAP
Lake Forest Park
Kenmore
Duvall
Kirkland
Redmond
KING
Yarrow Point
Seattle
Medina
Carnation
Bellevue
Sammamish
Mercer Island
Newcastle
Issaquah
Tukwila
Proposed Shoreline Management Area
Shoreline Master Program - City of Kirkland
Shoreline Management Area - Proposed
Kirkland City Limits
Kirkland Potential Annexation Area
Adjacent City Limits
Water Body
Highway
Arterial
0
1,100
2,200
Feet
Scale: 1" = 2,200'
Figure 1b

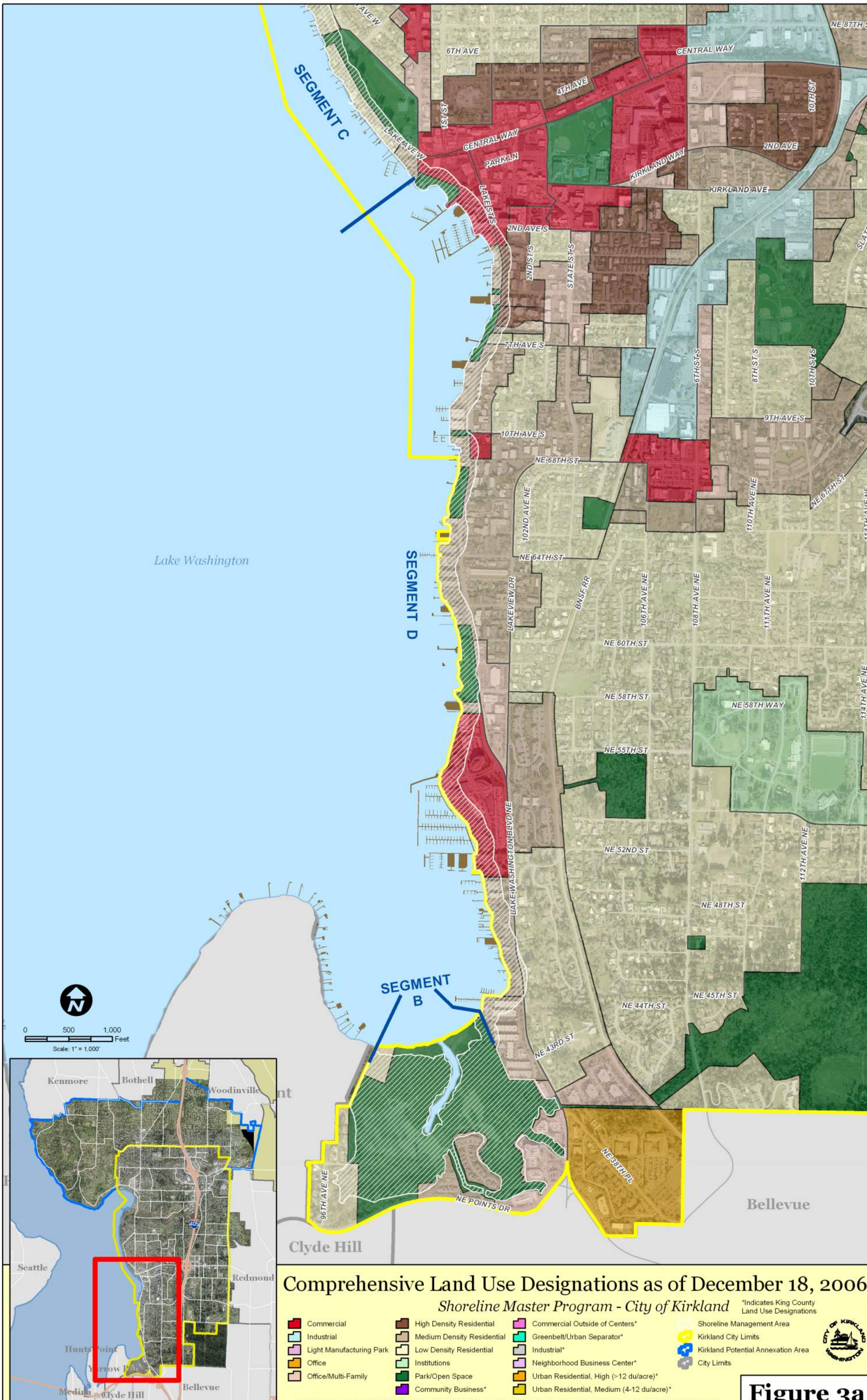


Previous Shoreline Designations

Shoreline Master Program - City of Kirkland

Ordinance 2938
(February 1986)

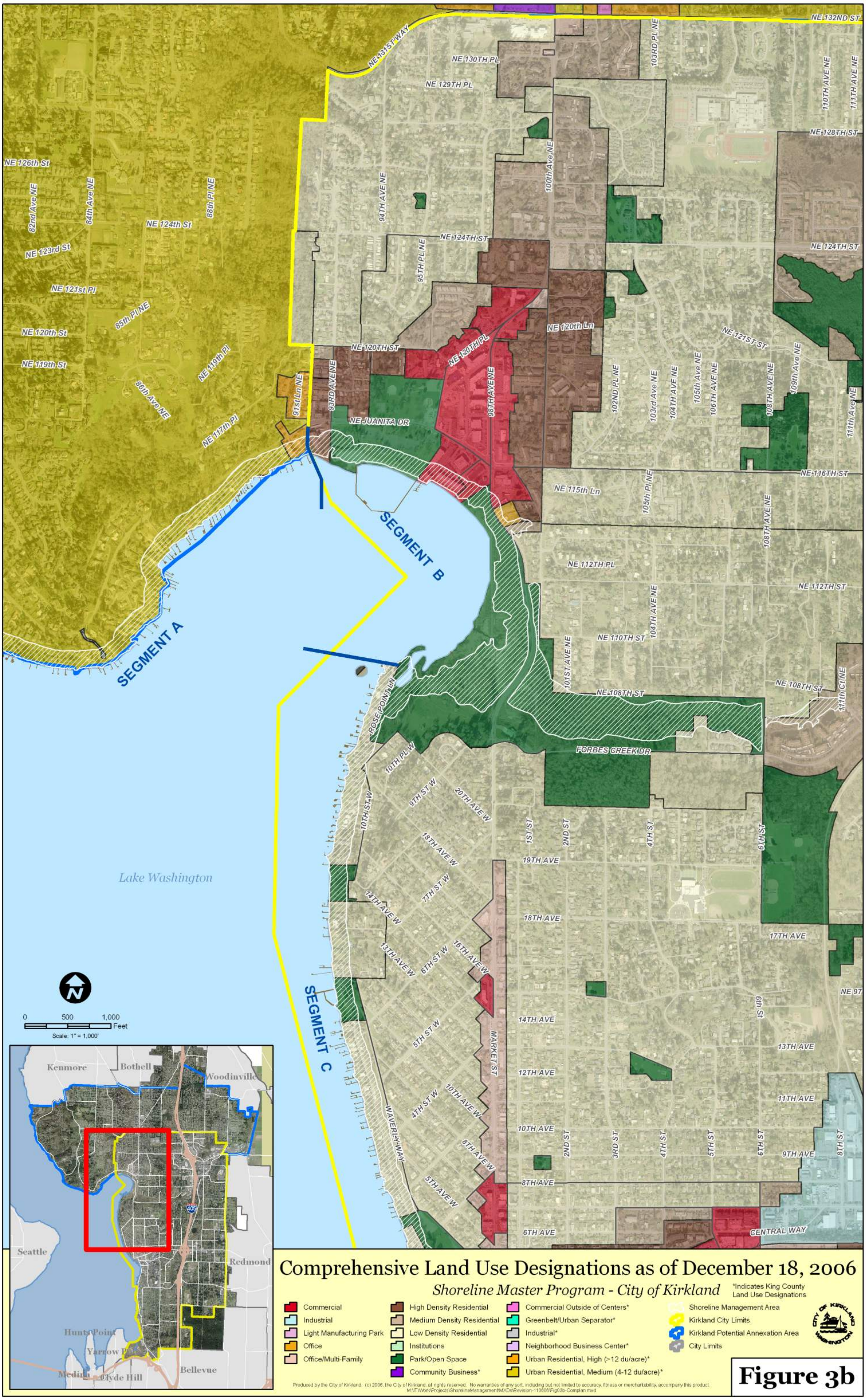
Figure 2



Comprehensive Land Use Designations as of December 18, 2006

Shoreline Master Program - City of Kirkland

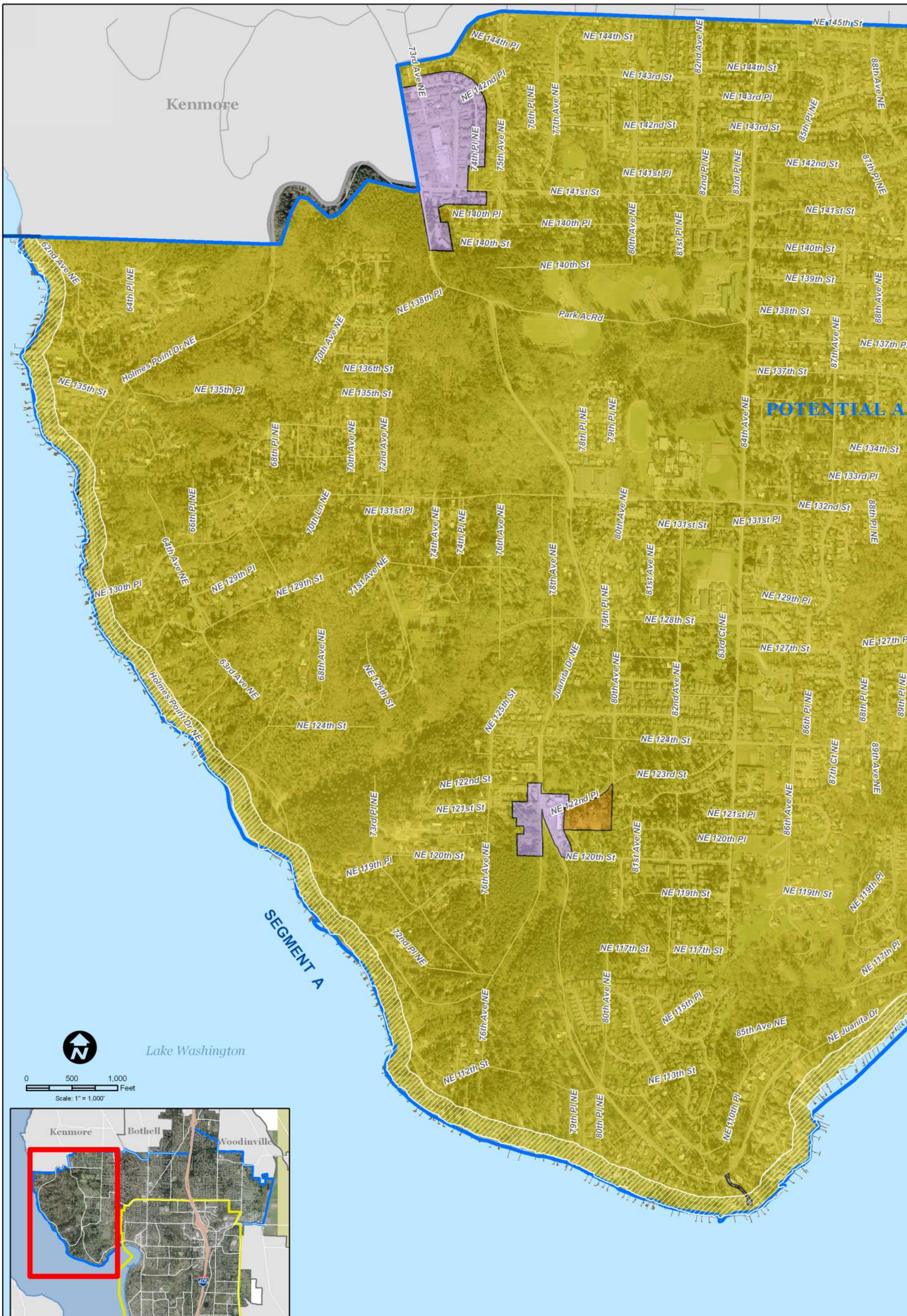
Figure 3a



Comprehensive Land Use Designations as of December 18, 2006

Shoreline Master Program - City of Kirkland

Figure 3b



Comprehensive Land Use Designations as of December 18, 2006

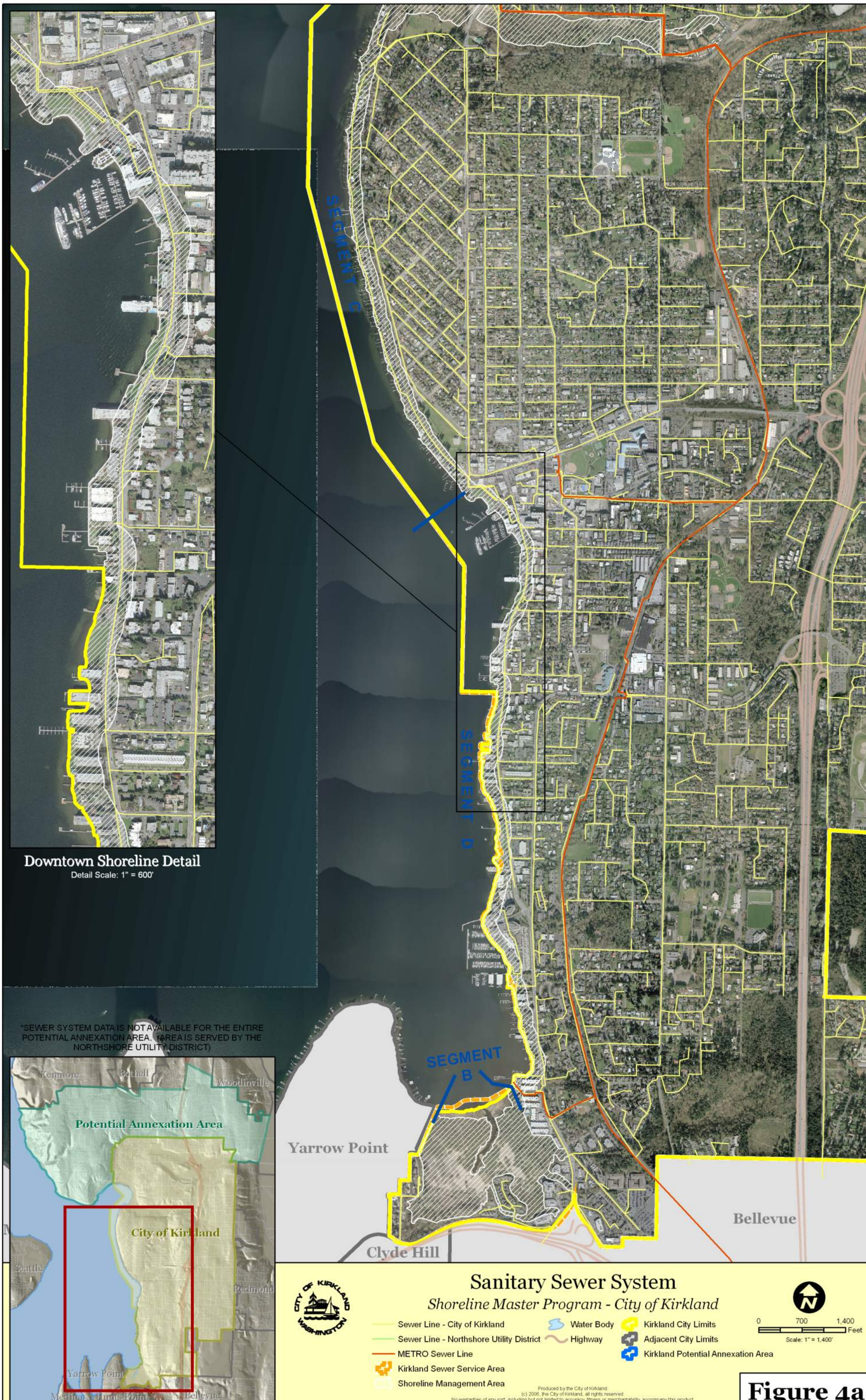
Shoreline Master Program - City of Kirkland

*Indicates King County Land Use Designations

- Commercial
- Industrial
- Light Manufacturing Park
- Office
- Office/Multi-Family
- High Density Residential
- Medium Density Residential
- Low Density Residential
- Institutions
- Park/Open Space
- Community Business*
- Commercial Outside of Centers*
- Greenbelt/Urban Separator*
- Industrial*
- Neighborhood Business Center*
- Urban Residential, High (>12 du/acre)*
- Urban Residential, Medium (4-12 du/acre)*
- Shoreline Management Area
- Kirkland City Limits
- Kirkland Potential Annexation Area
- City Limits

M:\IT\Work\Projects\ShorelineManagement\MXDs\Revision-110606\Fig03c-Complan.mxd

Figure 3c


SEGMENT C
SEGMENT D
SEGMENT B
Downtown Shoreline Detail
Detail Scale: 1" = 600'
*SEWER SYSTEM DATA IS NOT AVAILABLE FOR THE ENTIRE POTENTIAL ANNEXATION AREA. (AREA IS SERVED BY THE NORTHSHORE UTILITY DISTRICT)
Kenmore
Bothell
Woodinville
Potential Annexation Area
City of Kirkland
Seattle
Redmond
Yarrow Point
Medina
Hunts Point
Bellevue
Clyde Hill
Sanitary Sewer System
Shoreline Master Program - City of Kirkland
CITY OF KIRKLAND WASHINGTON
Sewer Line - City of Kirkland
Sewer Line - Northshore Utility District
METRO Sewer Line
Kirkland Sewer Service Area
Shoreline Management Area
Water Body
Highway
Kirkland City Limits
Adjacent City Limits
Kirkland Potential Annexation Area
0
700
1,400
Feet
Scale: 1" = 1,400'
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M:\IT\Work\Projects\ShorelineManagement\MXDs\Revision-110606\Fig04a-SewerLines.mxd

Figure 4a


Kenmore
POTENTIAL ANNEXATION A
SEGMENT A
SEGMENT B
SEGMENT C
Juanita Bay Detail
Detail Scale: 1" = 900'
*SEWER SYSTEM DATA IS NOT AVAILABLE FOR THE ENTIRE POTENTIAL ANNEXATION AREA. (AREA IS SERVED BY THE NORTHSHORE UTILITY DISTRICT)
Kenmore
Bothell
Woodinville
Potential Annexation Area
City of Kirkland
Seattle
Redmond
Yarrow Point
Medina
Hunts Point
Bellevue
Sanitary Sewer System
Shoreline Master Program - City of Kirkland
Sewer Line - City of Kirkland
Sewer Line - Northshore Utility District
METRO Sewer Line
Kirkland Sewer Service Area
Shoreline Management Area
Water Body
Highway
Kirkland City Limits
Adjacent City Limits
Kirkland Potential Annexation Area
0
700
1,400
Feet
Scale: 1" = 1,400'
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M:\IT\Work\Projects\ShorelineManagement\MXDs\Revision-110606\Fig04b-SewerLines.mxd

Figure 4b


SEGMENT C
SEGMENT D
SEGMENT B
Lake Washington
Yarrow Point
Clyde Hill
Bellevue
Downtown Shoreline Detail
Detail Scale: 1" = 600'
*SURFACE WATER SYSTEM DATA IS NOT AVAILABLE FOR THE ENTIRE POTENTIAL ANNEXATION AREA. (AREA IS CURRENTLY SERVED BY KING COUNTY)
Kenmore
Bothell
Woodinville
Potential Annexation Area
City of Kirkland
Seattle
Redmond
Yarrow Point
Medina
Hunts Point
Bellevue
Surface Water System w/ Outfalls
Shoreline Master Program - City of Kirkland
CITY OF KIRKLAND WASHINGTON
Outfalls Within SMA
Outfalls Outside SMA
Surface Water Pipe/Culvert
Ditch or Swale
Stream
Shoreline Management Area
Surface Water Drainage Basins
Water Body
Highway
Kirkland City Limits
Adjacent City Limits
Kirkland Potential Annexation Area
0 700 1,400 Feet
Scale: 1" = 1,400'
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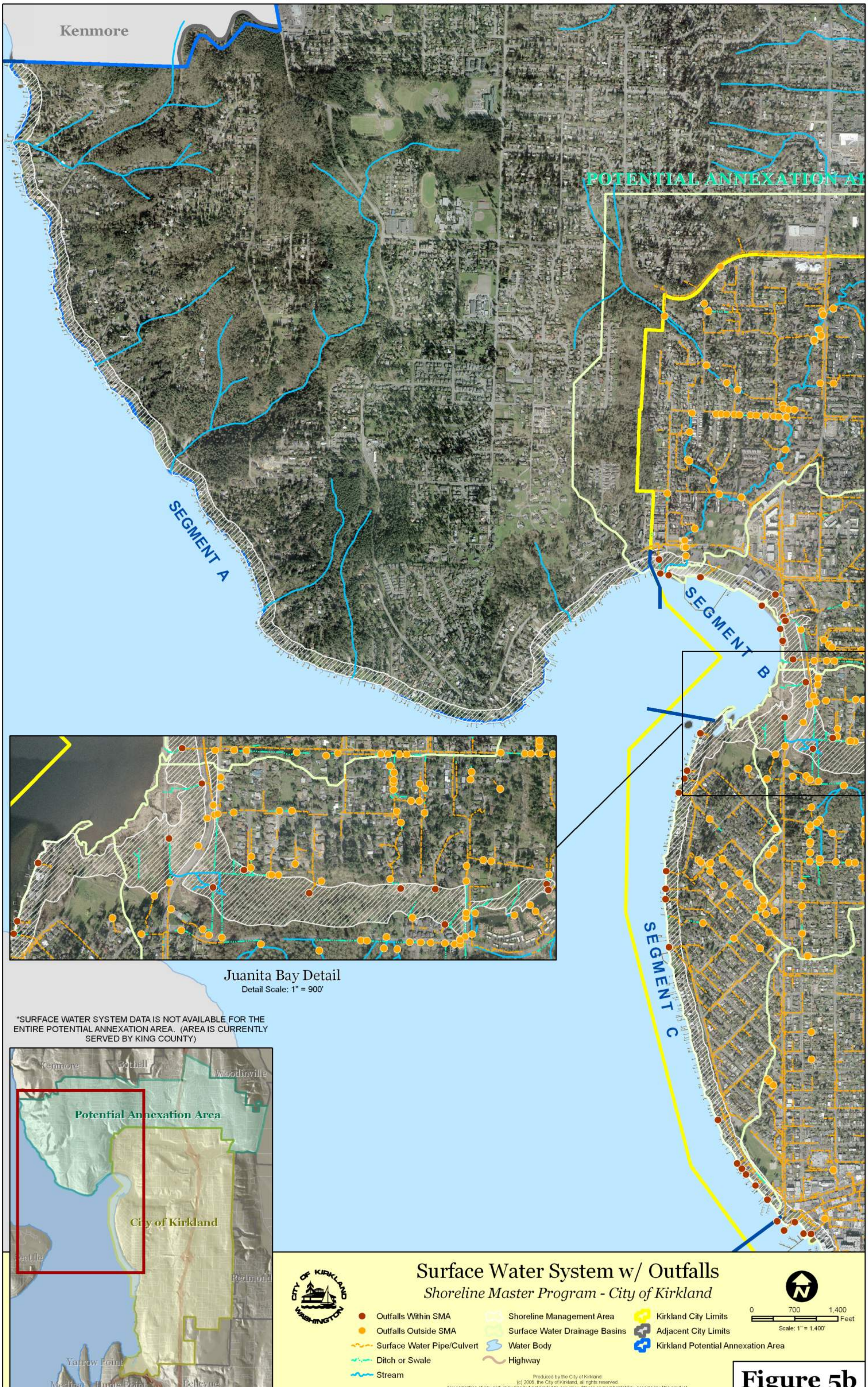
M:\IT\Work\Projects\ShorelineManagement\MXDs\Revision-110606\Fig05a-StormLines.mxd

Figure 5a



Kenmore
POTENTIAL ANNEXATION AR
SEGMENT A
SEGMENT B
SEGMENT C
Juanita Bay Detail
Detail Scale: 1" = 900'
*SURFACE WATER SYSTEM DATA IS NOT AVAILABLE FOR THE ENTIRE POTENTIAL ANNEXATION AREA. (AREA IS CURRENTLY SERVED BY KING COUNTY)
Kenmore
Bothell
Woodinville
Potential Annexation Area
City of Kirkland
Seattle
Redmond
Yarrow Point
Medina
Hunts Point
Bellevue
Surface Water System w/ Outfalls
Shoreline Master Program - City of Kirkland
CITY OF KIRKLAND WASHINGTON
Outfalls Within SMA
Outfalls Outside SMA
Surface Water Pipe/Culvert
Ditch or Swale
Stream
Shoreline Management Area
Surface Water Drainage Basins
Water Body
Highway
Kirkland City Limits
Adjacent City Limits
Kirkland Potential Annexation Area
N
0
700
1,400
Feet
Scale: 1" = 1,400'
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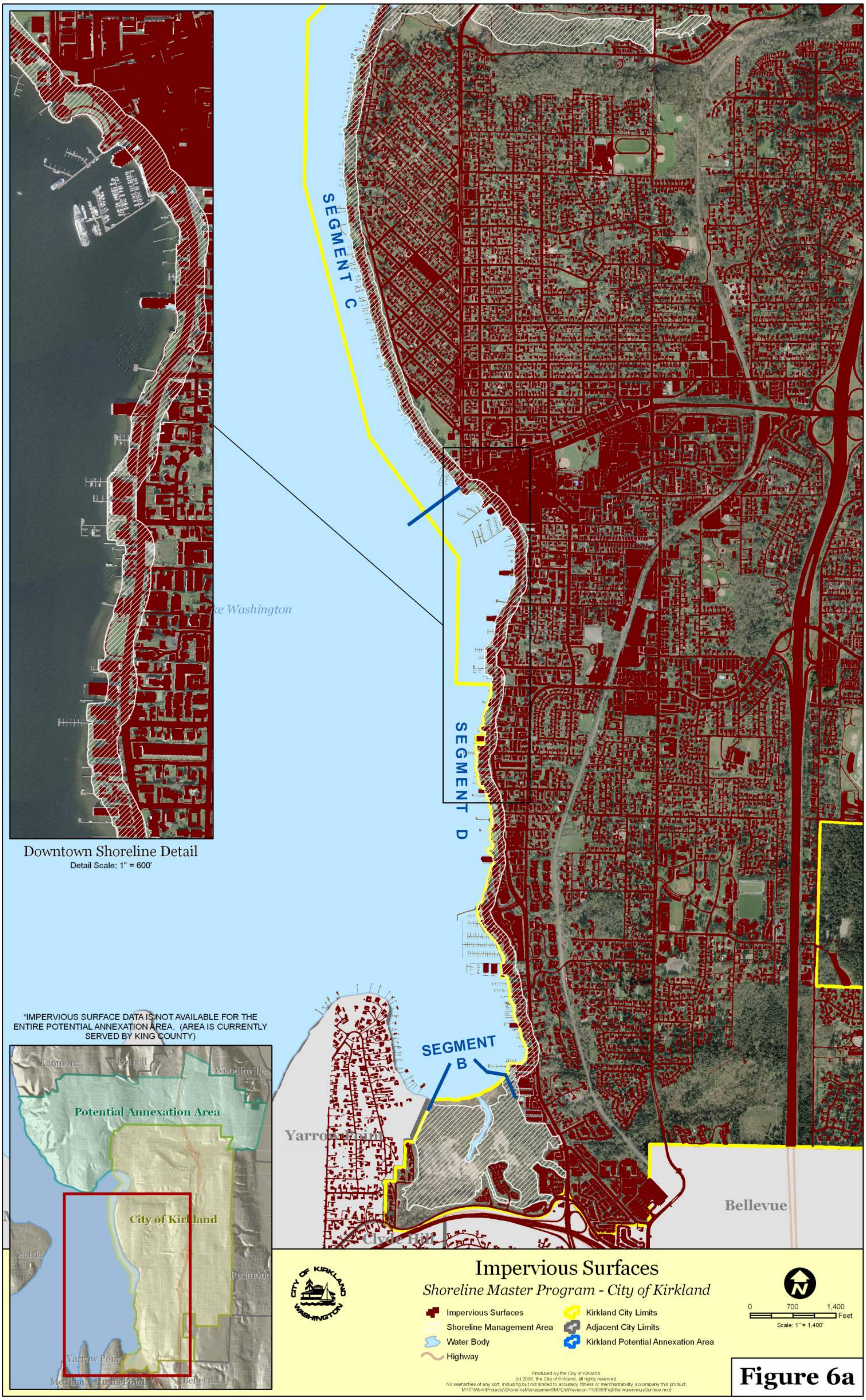
M:\IT\Work\Projects\ShorelineManagement\MXDs\Revision-110606\Fig05b-StormLines.mxd

Figure 5b



SEGMENT C
SEGMENT D
SEGMENT B
Lake Washington
Downtown Shoreline Detail
Detail Scale: 1" = 600'
*IMPERVIOUS SURFACE DATA IS NOT AVAILABLE FOR THE ENTIRE POTENTIAL ANNEXATION AREA. (AREA IS CURRENTLY SERVED BY KING COUNTY)
Kenmore
Bothell
Woodinville
Potential Annexation Area
City of Kirkland
Seattle
Redmond
Yarrow Point
Medina
Hunts Point
Bellevue
Yarrow Point
Clyde Hill
Bellevue
Impervious Surfaces
Shoreline Master Program - City of Kirkland
CITY OF KIRKLAND WASHINGTON
Impervious Surfaces
Shoreline Management Area
Water Body
Highway
Kirkland City Limits
Adjacent City Limits
Kirkland Potential Annexation Area
0
700
1,400
Feet
Scale: 1" = 1,400'
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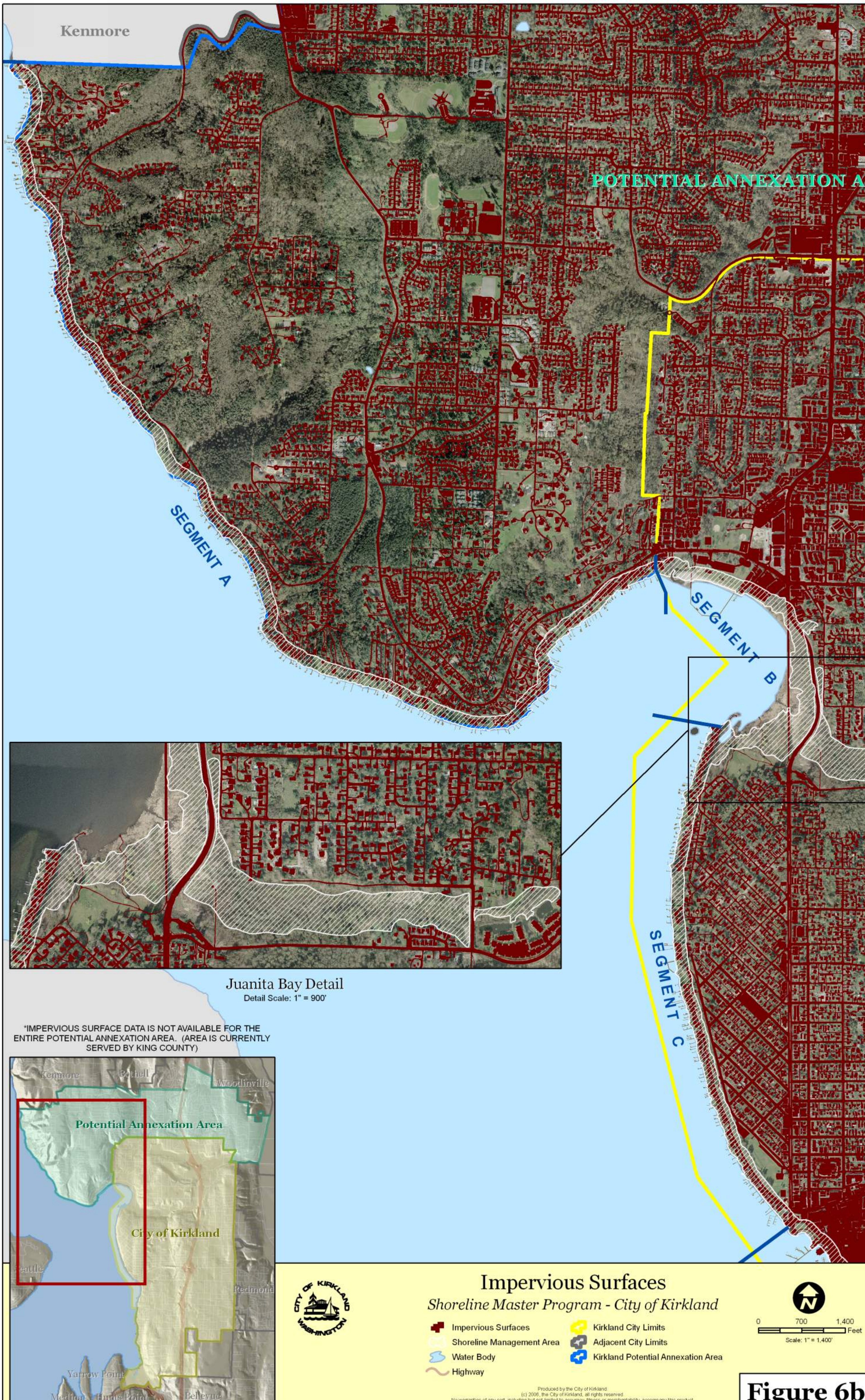
M:\IT\Work\Projects\ShorelineManagement\MXDs\Revision-110606\Fig06a-ImperviousSurface.mxd

Figure 6a


Kenmore
POTENTIAL ANNEXATION A
SEGMENT A
SEGMENT B
SEGMENT C
Juanita Bay Detail
Detail Scale: 1" = 900'
*IMPERVIOUS SURFACE DATA IS NOT AVAILABLE FOR THE ENTIRE POTENTIAL ANNEXATION AREA. (AREA IS CURRENTLY SERVED BY KING COUNTY)
Kenmore
Bothell
Woodinville
Potential Annexation Area
City of Kirkland
Seattle
Redmond
Yarrow Point
Medina
Hunts Point
Bellevue
CITY OF KIRKLAND WASHINGTON
Impervious Surfaces
Shoreline Master Program - City of Kirkland
Impervious Surfaces
Shoreline Management Area
Water Body
Highway
Kirkland City Limits
Adjacent City Limits
Kirkland Potential Annexation Area
0
700
1,400
Feet
Scale: 1" = 1,400'
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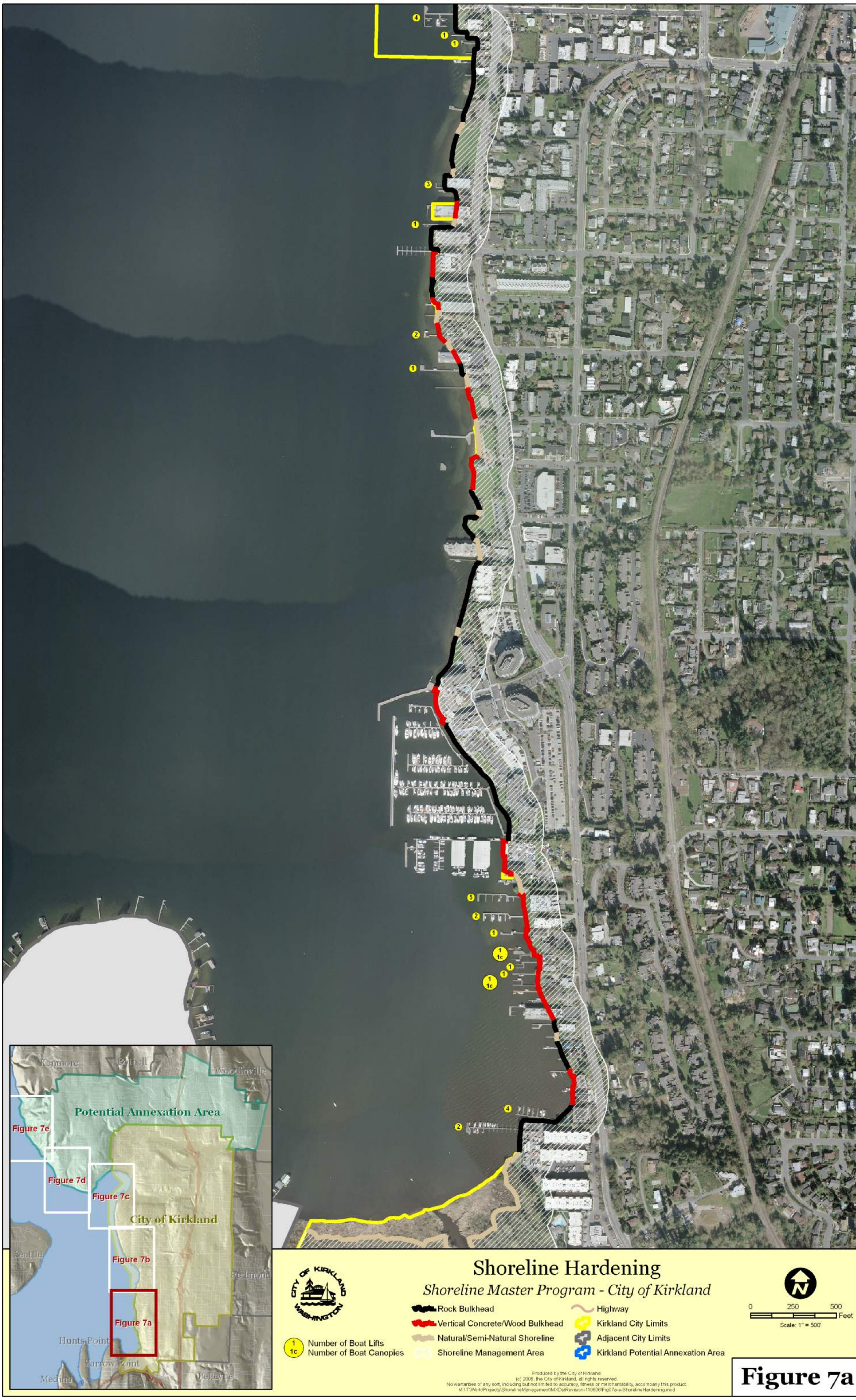
M:\IT\Work\Projects\ShorelineManagement\MXDs\Revision-110606\Fig06b-ImperviousSurface.mxd

Figure 6b



Kenmore
Bothell
Woodinville
Potential Annexation Area
Figure 7e
Figure 7d
Figure 7c
City of Kirkland
Seattle
Figure 7b
Redmond
Figure 7a
Hunts Point
Yarrow Point
Medina
Bellevue
Shoreline Hardening
Shoreline Master Program - City of Kirkland
CITY OF KIRKLAND WASHINGTON
Rock Bulkhead
Vertical Concrete/Wood Bulkhead
Natural/Semi-Natural Shoreline
Shoreline Management Area
Highway
Kirkland City Limits
Adjacent City Limits
Kirkland Potential Annexation Area
1 1c Number of Boat Lifts Number of Boat Canopies
0 250 500 Feet
Scale: 1" = 500'
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M:\IT\Work\Projects\ShorelineManagement\MXDs\Revision-110606\Fig07a-e-ShorelineHardening.mxd

Figure 7a

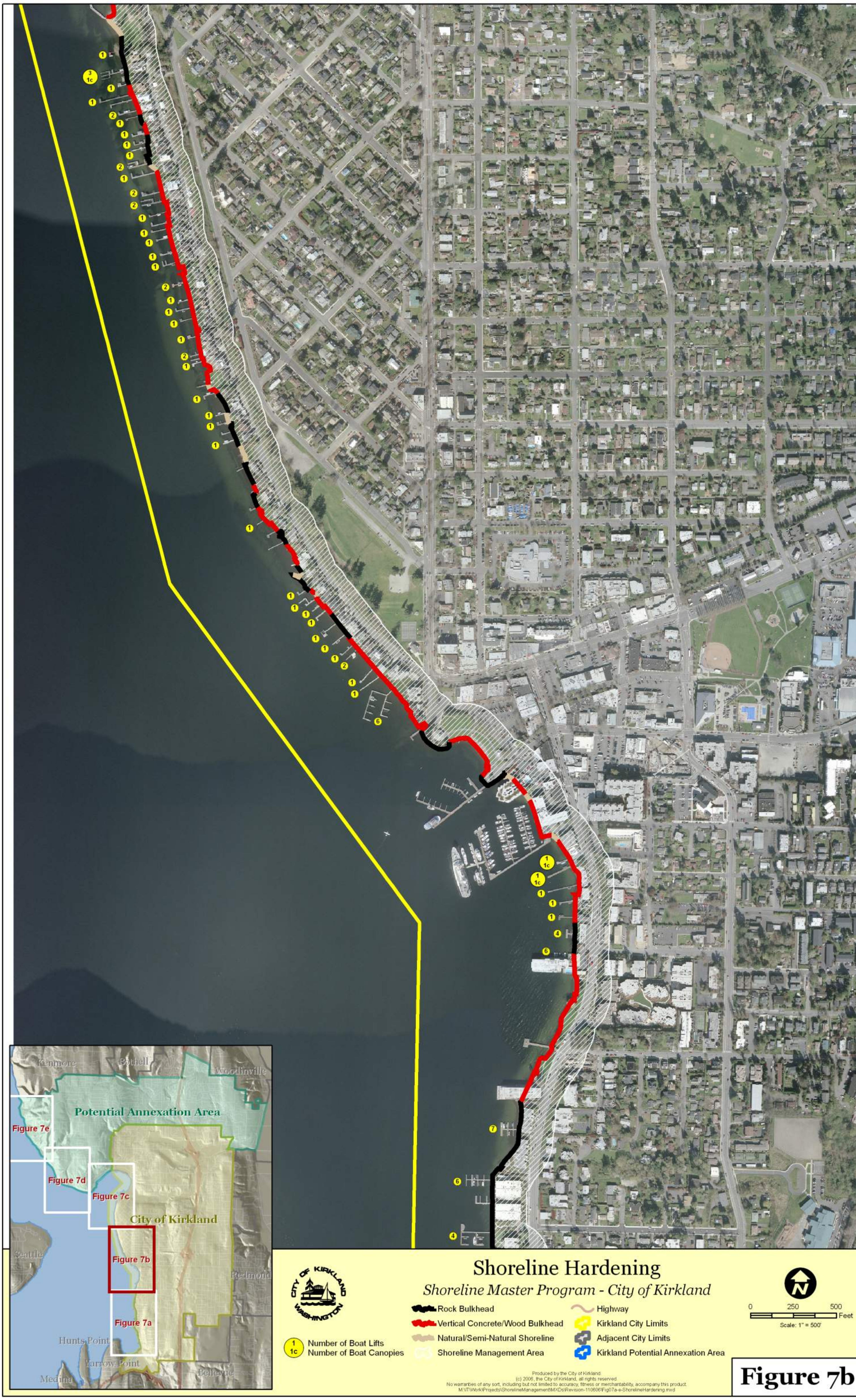
Kenmore
Bothell
Woodinville
Potential Annexation Area
Figure 7e
Figure 7d
Figure 7c
City of Kirkland
Seattle
Figure 7b
Redmond
Figure 7a
Hunts Point
Yarrow Point
Medina
Bellevue
Shoreline Hardening
Shoreline Master Program - City of Kirkland
CITY OF KIRKLAND WASHINGTON
Rock Bulkhead
Vertical Concrete/Wood Bulkhead
Natural/Semi-Natural Shoreline
Shoreline Management Area
Highway
Kirkland City Limits
Adjacent City Limits
Kirkland Potential Annexation Area
1 1c Number of Boat Lifts Number of Boat Canopies
0 250 500 Feet
Scale: 1" = 500'
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Figure 7b

Kenmore
Bothell
Woodinville
Potential Annexation Area
Figure 7e
Figure 7d
Figure 7c
City of Kirkland
Seattle
Figure 7b
Redmond
Figure 7a
Hunts Point
Yarrow Point
Medina
Bellevue
Shoreline Hardening
Shoreline Master Program - City of Kirkland
CITY OF KIRKLAND WASHINGTON
Rock Bulkhead
Vertical Concrete/Wood Bulkhead
Natural/Semi-Natural Shoreline
Shoreline Management Area
Highway
Kirkland City Limits
Adjacent City Limits
Kirkland Potential Annexation Area
Number of Boat Lifts
Number of Boat Canopies
0 250 500 Feet
Scale: 1" = 500'
N
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M:\IT\Work\Projects\ShorelineManagement\MXDs\Revision-110606\Fig07a-e-ShorelineHardening.mxd

Figure 7c


Kenmore
Bothell
Woodinville
Potential Annexation Area
Figure 7e
Figure 7d
Figure 7c
City of Kirkland
Seattle
Figure 7b
Redmond
Figure 7a
Hunts Point
Yarrow Point
Medina
Bellevue
Shoreline Hardening
Shoreline Master Program - City of Kirkland
CITY OF KIRKLAND WASHINGTON
Rock Bulkhead
Vertical Concrete/Wood Bulkhead
Natural/Semi-Natural Shoreline
Shoreline Management Area
Highway
Kirkland City Limits
Adjacent City Limits
Kirkland Potential Annexation Area
1 Number of Boat Lifts
1c Number of Boat Canopies
0 250 500 Feet
Scale: 1" = 500'
N
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M:\IT\Work\Projects\ShorelineManagement\MXDs\Revision-110606\Fig07a-e-ShorelineHardening.mxd

Figure 7d

Shoreline Hardening

Shoreline Master Program - City of Kirkland

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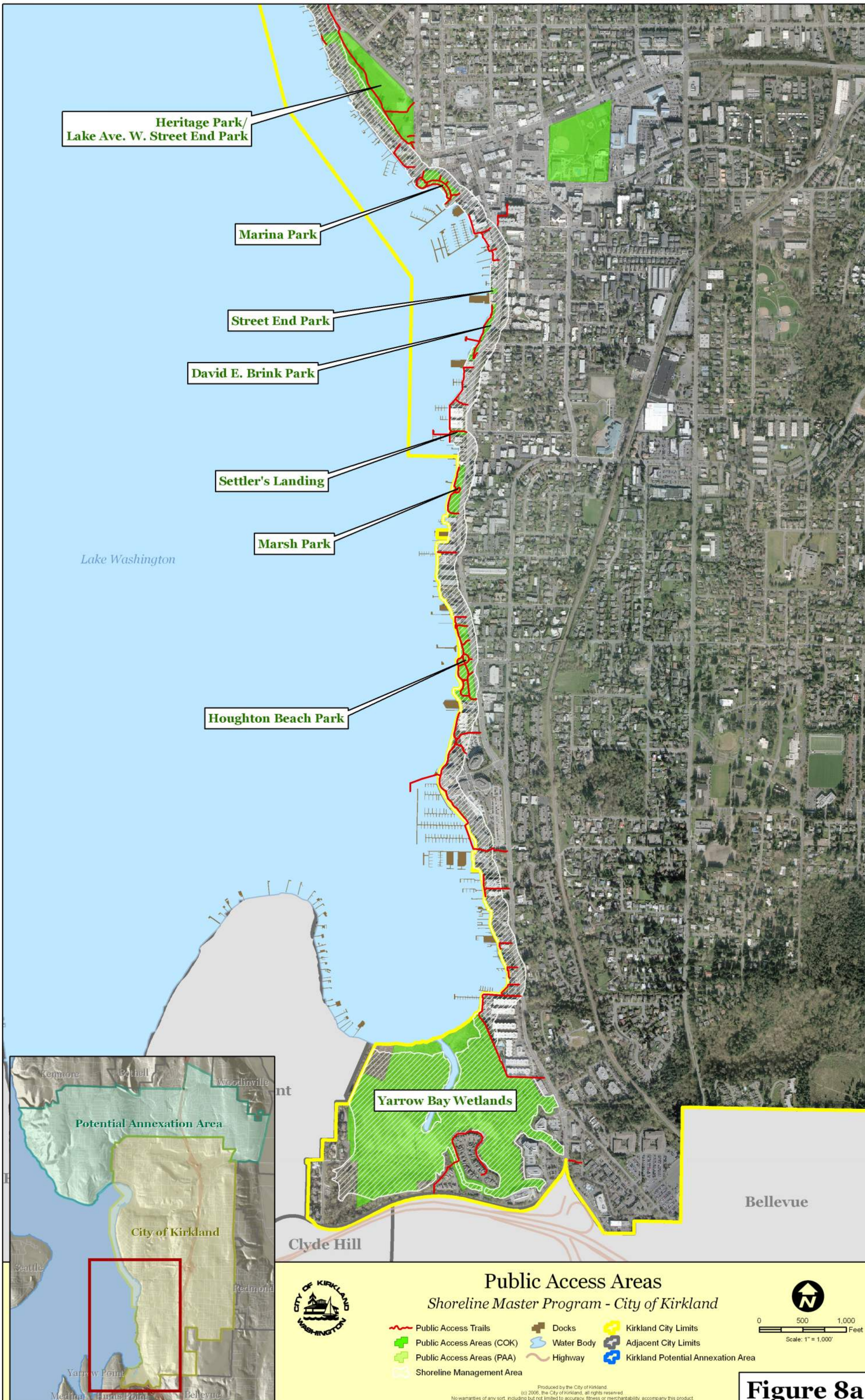
M:\IT\Work\Projects\ShorelineManagement\MXDs\Revision-110606\Fig07a-e-ShorelineHardening.mxd

Figure 7e



Heritage Park/
Lake Ave. W. Street End Park
Marina Park
Street End Park
David E. Brink Park
Settler's Landing
Marsh Park
Lake Washington
Houghton Beach Park
Yarrow Bay Wetlands
Bellevue
Clyde Hill
Kenmore
Bothell
Woodinville
Potential Annexation Area
City of Kirkland
Seattle
Redmond
Yarrow Point
Medina
Hunts Point
Bellevue
Public Access Areas
Shoreline Master Program - City of Kirkland
CITY OF KIRKLAND WASHINGTON
Public Access Trails
Public Access Areas (COK)
Public Access Areas (PAA)
Shoreline Management Area
Docks
Water Body
Highway
Kirkland City Limits
Adjacent City Limits
Kirkland Potential Annexation Area
N
0
500
1,000
Feet
Scale: 1" = 1,000'
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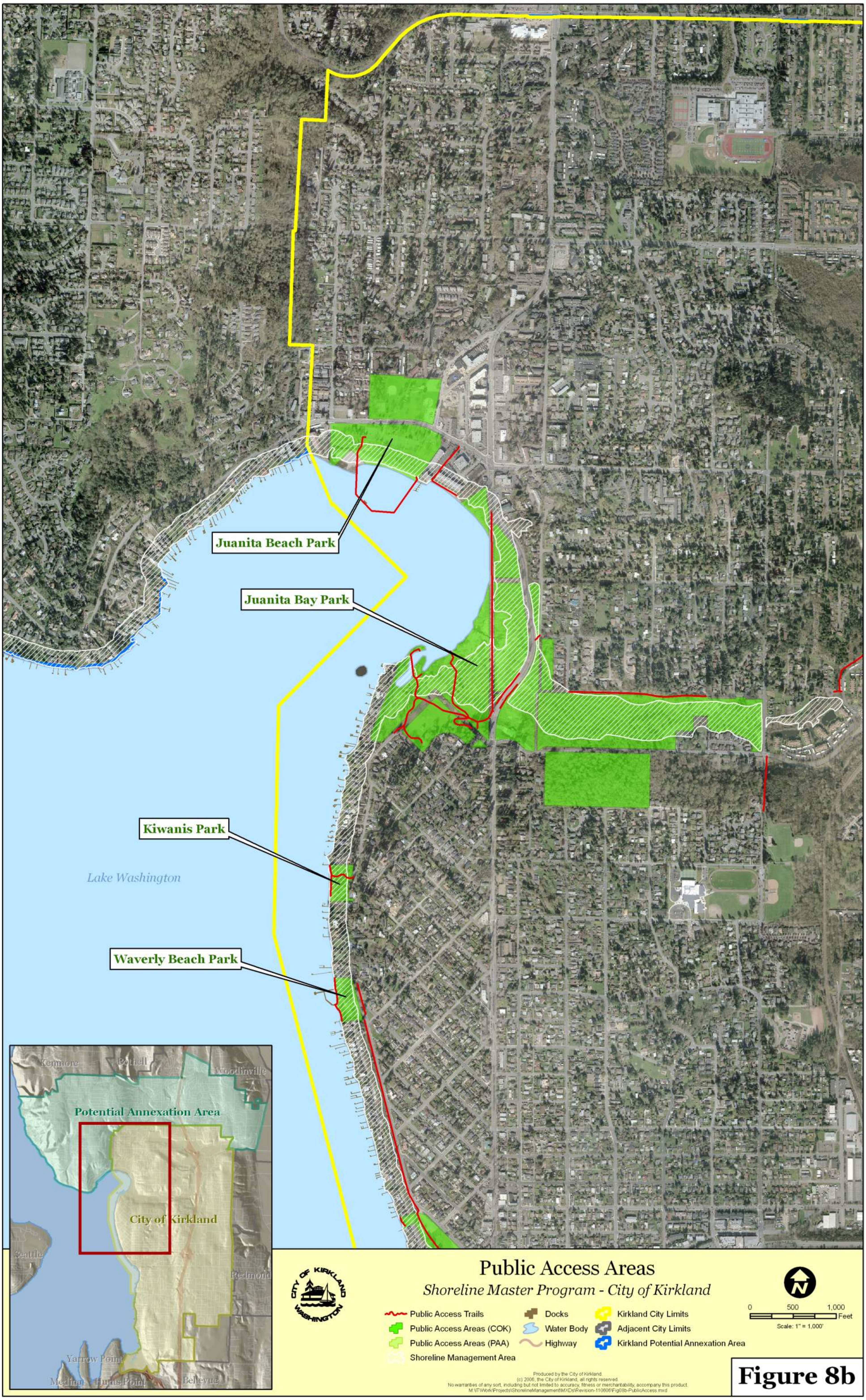
Figure 8a


Juanita Beach Park
Juanita Bay Park
Kiwanis Park
Lake Washington
Waverly Beach Park
Kenmore
Bothell
Woodinville
Potential Annexation Area
City of Kirkland
Seattle
Redmond
Yarrow Point
Medina
Hunts Point
Bellevue
CITY OF KIRKLAND WASHINGTON
Public Access Areas
Shoreline Master Program - City of Kirkland
Public Access Trails
Public Access Areas (COK)
Public Access Areas (PAA)
Shoreline Management Area
Docks
Water Body
Highway
Kirkland City Limits
Adjacent City Limits
Kirkland Potential Annexation Area
N
0
500
1,000
Feet
Scale: 1" = 1,000'
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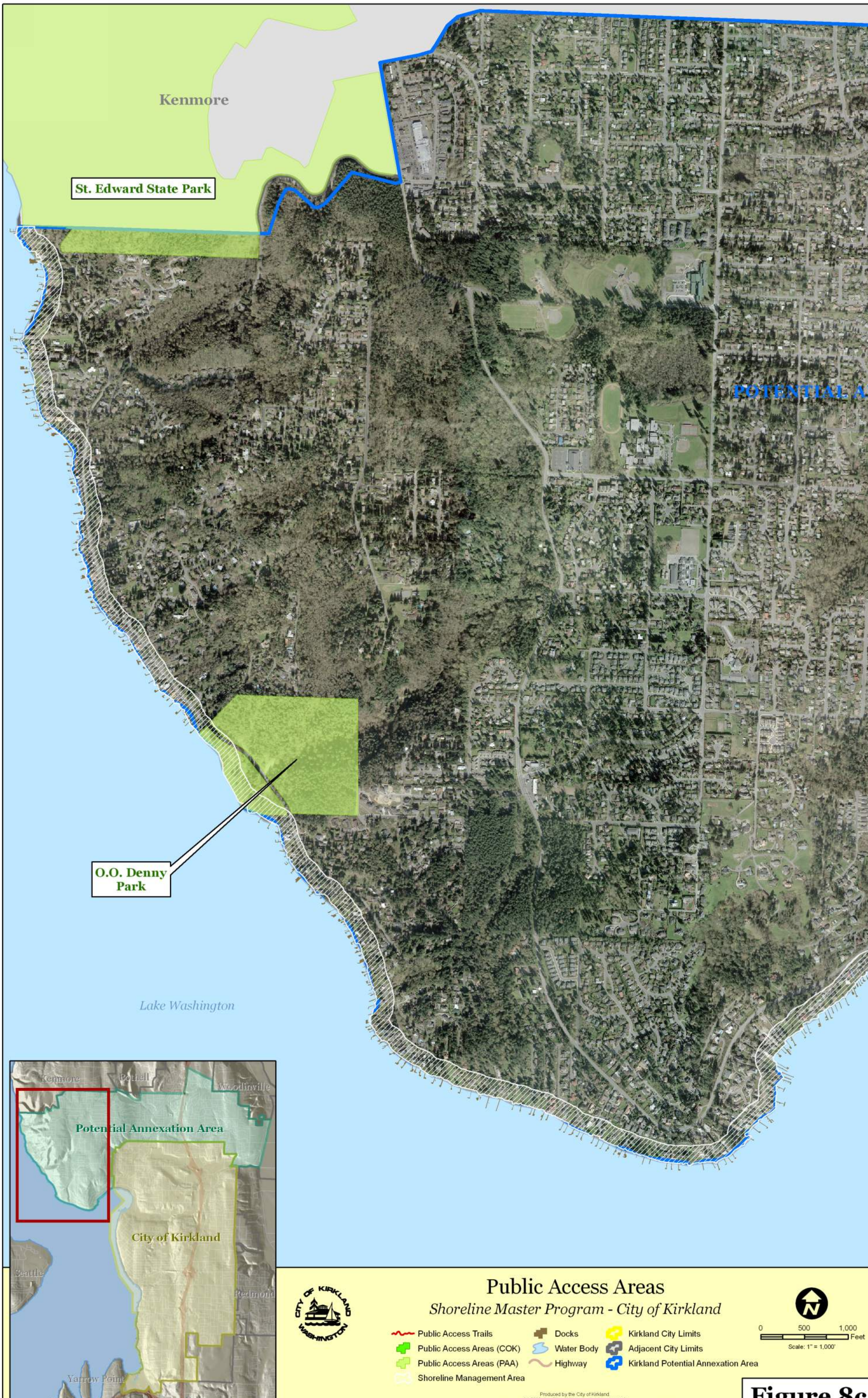
M:\IT\Work\Projects\ShorelineManagement\MXDs\Revision-110606\Fig08b-PublicAccess.mxd

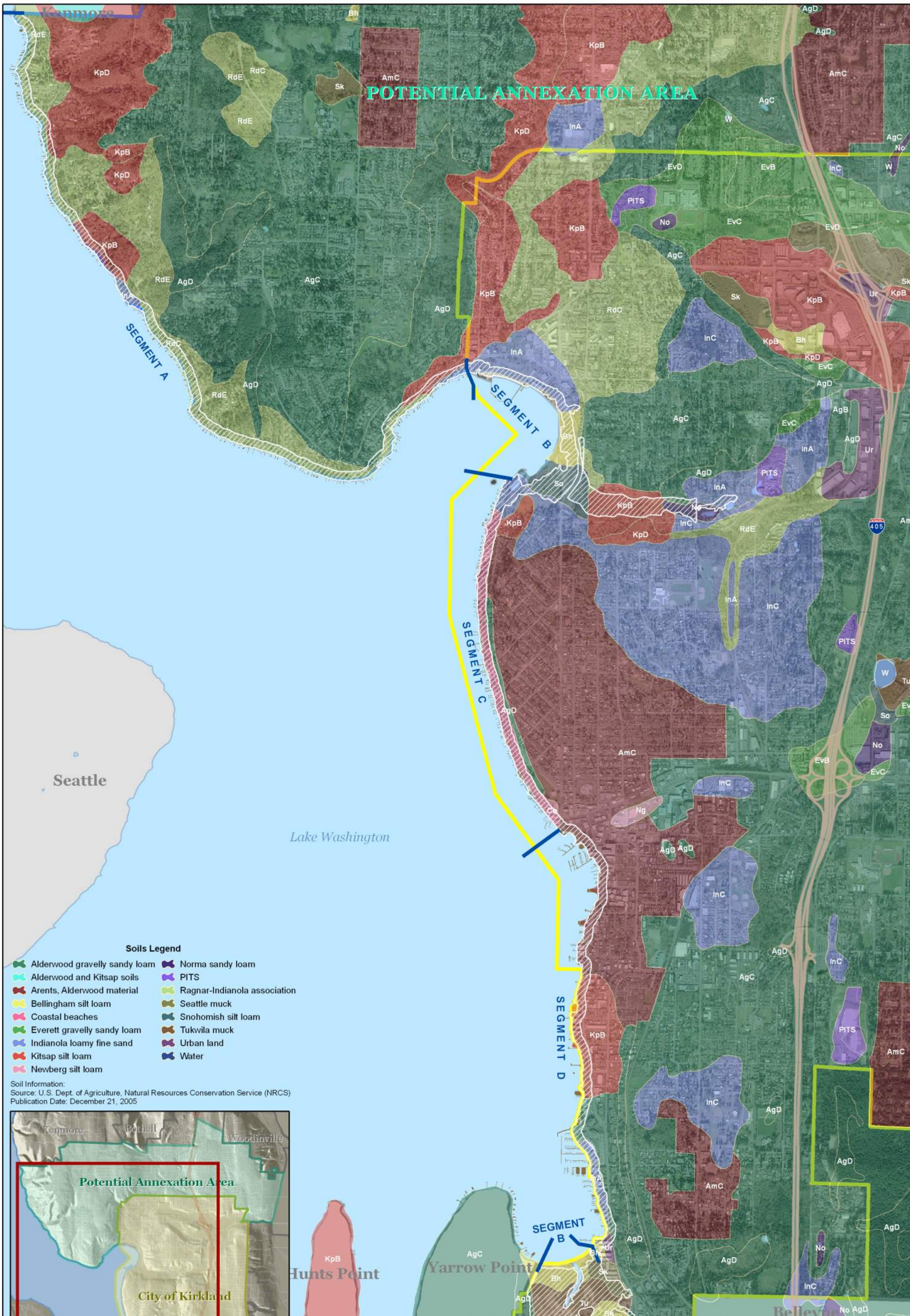
Figure 8b



Public Access Areas

Shoreline Master Program - City of Kirkland

Figure 8c



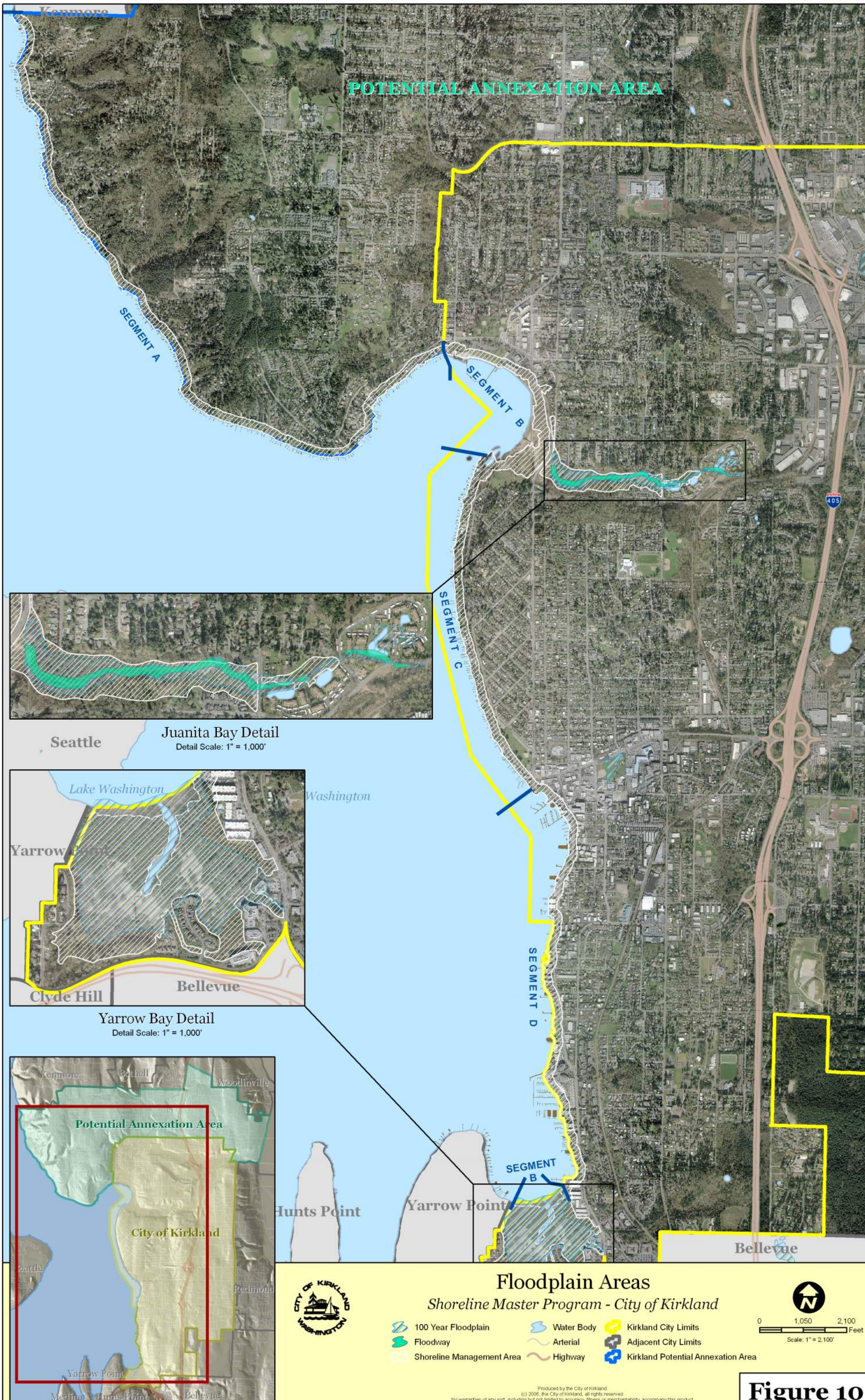
NRCS Soils

Shoreline Master Program - City of Kirkland

Produced by the City of Kirkland

M:\IT\Work\Projects\ShorelineManagement\MXDs\Revision-110606\Fig09-NRCS Soils.mxd

Figure 9



Kenmore
POTENTIAL ANNEXATION AREA
SEGMENT A
SEGMENT B
SEGMENT C
SEGMENT D
SEGMENT B
405
Seattle
Lake Washington
Washington
Yarrow Point
Clyde Hill
Bellevue
Hunts Point
Yarrow Point
Bellevue
Juanita Bay Detail
Detail Scale: 1" = 1,000'
Yarrow Bay Detail
Detail Scale: 1" = 1,000'
Kenmore
Bothell
Woodinville
Potential Annexation Area
City of Kirkland
Seattle
Redmond
Yarrow Point
Medina
Hunts Point
Bellevue
Floodplain Areas
Shoreline Master Program - City of Kirkland
City of Kirkland Washington
100 Year Floodplain
Floodway
Shoreline Management Area
Water Body
Arterial
Highway
Kirkland City Limits
Adjacent City Limits
Kirkland Potential Annexation Area
0 1,050 2,100 Feet
Scale: 1" = 2,100'
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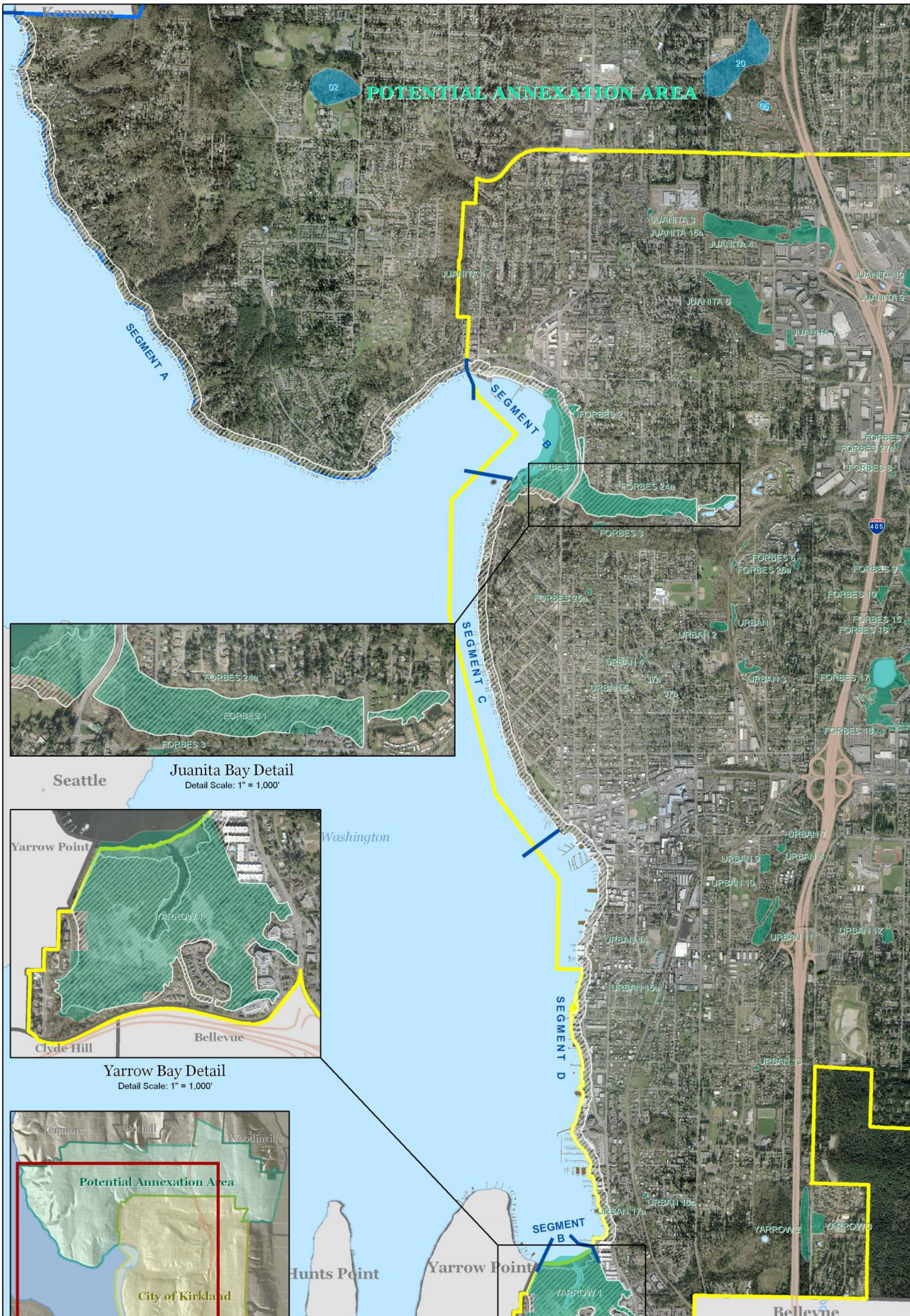
M:\IT\Work\Projects\ShorelineManagement\MXDs\Revision-110606\Fig10-FloodplainAreas.mxd
Figure 10



Wetlands

Shoreline Master Program - City of Kirkland

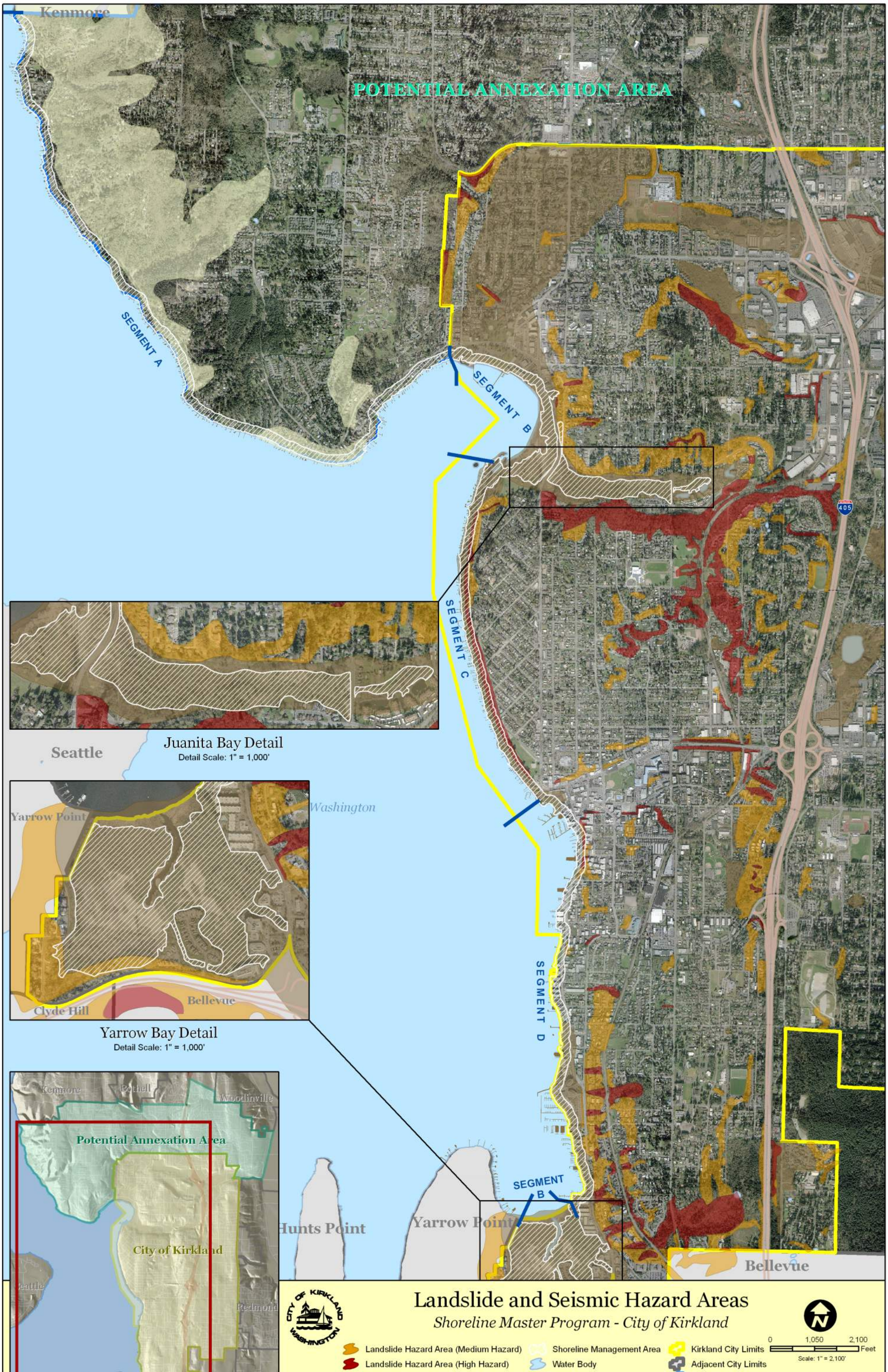
CITY OF KIRKLAND WASHINGTON

Wetlands (City of Kirkland)
Wetlands (King County)
Shoreline Management Area
Water Body
Highway
Kirkland City Limits
Adjacent City Limits
Kirkland Potential Annexation Area

0 1,050 2,100 Feet
Scale: 1" = 2,100'

M:\IT\Work\Projects\ShorelineManagement\MXDs\Revision-110606\Fig11-Wetlands.mxd

Figure 11


Kenmore
POTENTIAL ANNEXATION AREA
SEGMENT A
SEGMENT B
SEGMENT C
SEGMENT D
SEGMENT B
405
Seattle
Washington
Yarrow Point
Hunts Point
Bellevue
Juanita Bay Detail
Detail Scale: 1" = 1,000'
Yarrow Point
Clyde Hill
Bellevue
Yarrow Bay Detail
Detail Scale: 1" = 1,000'
Kenmore
Bothell
Woodinville
Potential Annexation Area
City of Kirkland
Seattle
Redmond
Yarrow Point
Medina
Hunts Point
Bellevue
Landslide and Seismic Hazard Areas
Shoreline Master Program - City of Kirkland
Landslide Hazard Area (Medium Hazard)
Landslide Hazard Area (High Hazard)
Landslide Hazard Area (King County)
Seismic Hazard Area
Shoreline Management Area
Water Body
Highway
Kirkland City Limits
Adjacent City Limits
Kirkland Potential Annexation Area
0
1,050
2,100
Feet
Scale: 1" = 2,100'
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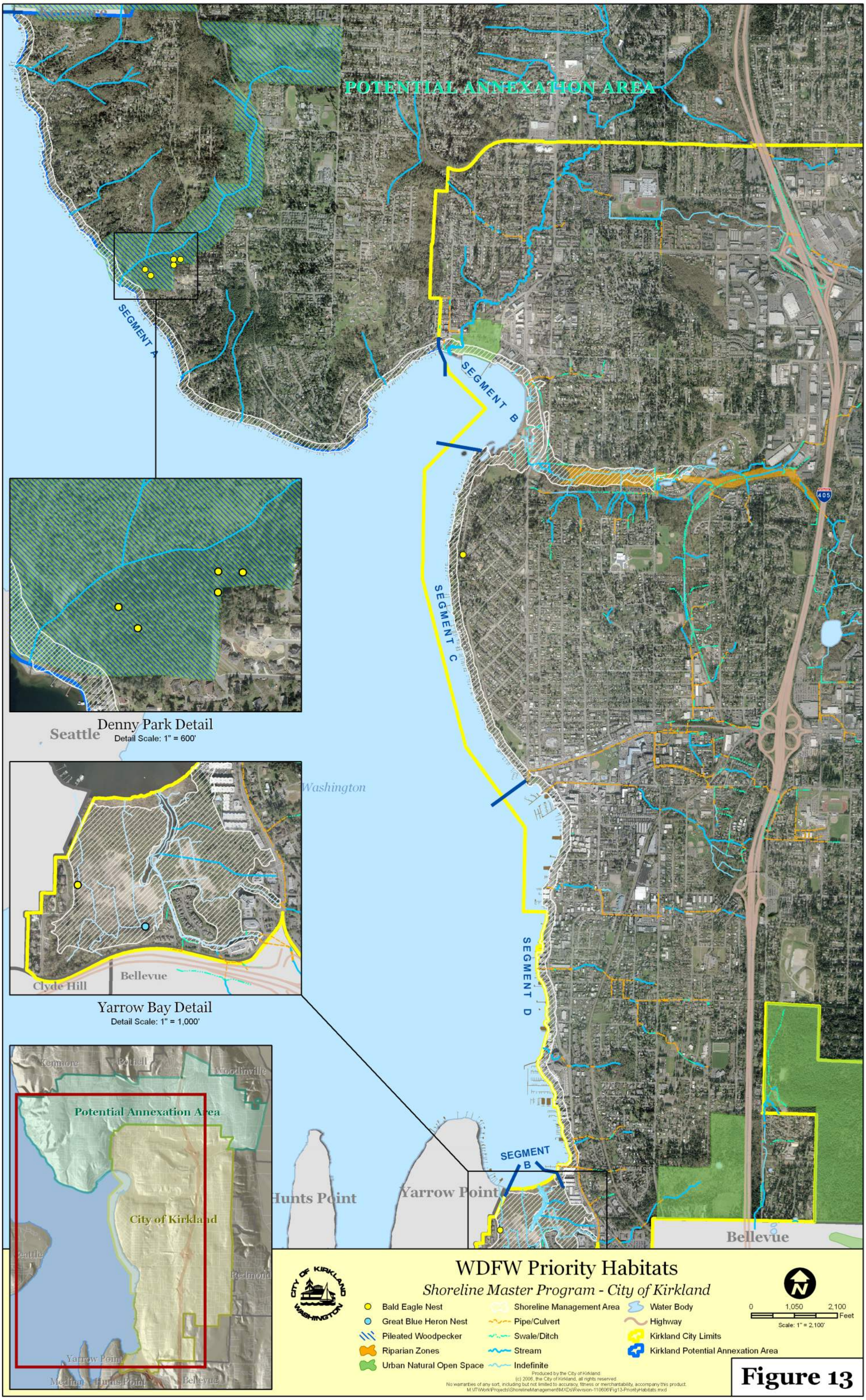
M:\IT\Work\Projects\ShorelineManagement\MXDs\Revision-110606\Fig12-HazardAreas.mxd

Figure 12


POTENTIAL ANNEXATION AREA
SEGMENT A
SEGMENT B
SEGMENT C
SEGMENT D
SEGMENT B
405
Washington
Seattle
Denny Park Detail
Detail Scale: 1" = 600'
Clyde Hill
Bellevue
Yarrow Bay Detail
Detail Scale: 1" = 1,000'
Kenmore
Bothell
Woodinville
Potential Annexation Area
City of Kirkland
Seattle
Redmond
Yarrow Point
Medina
Hunts Point
Bellevue
Hunts Point
Yarrow Point
Bellevue
CITY OF KIRKLAND WASHINGTON
WDFW Priority Habitats
Shoreline Master Program - City of Kirkland
Bald Eagle Nest
Great Blue Heron Nest
Pileated Woodpecker
Riparian Zones
Urban Natural Open Space
Shoreline Management Area
Pipe/Culvert
Swale/Ditch
Stream
Indefinite
Water Body
Highway
Kirkland City Limits
Kirkland Potential Annexation Area
N
0 1,050 2,100 Feet
Scale: 1" = 2,100'
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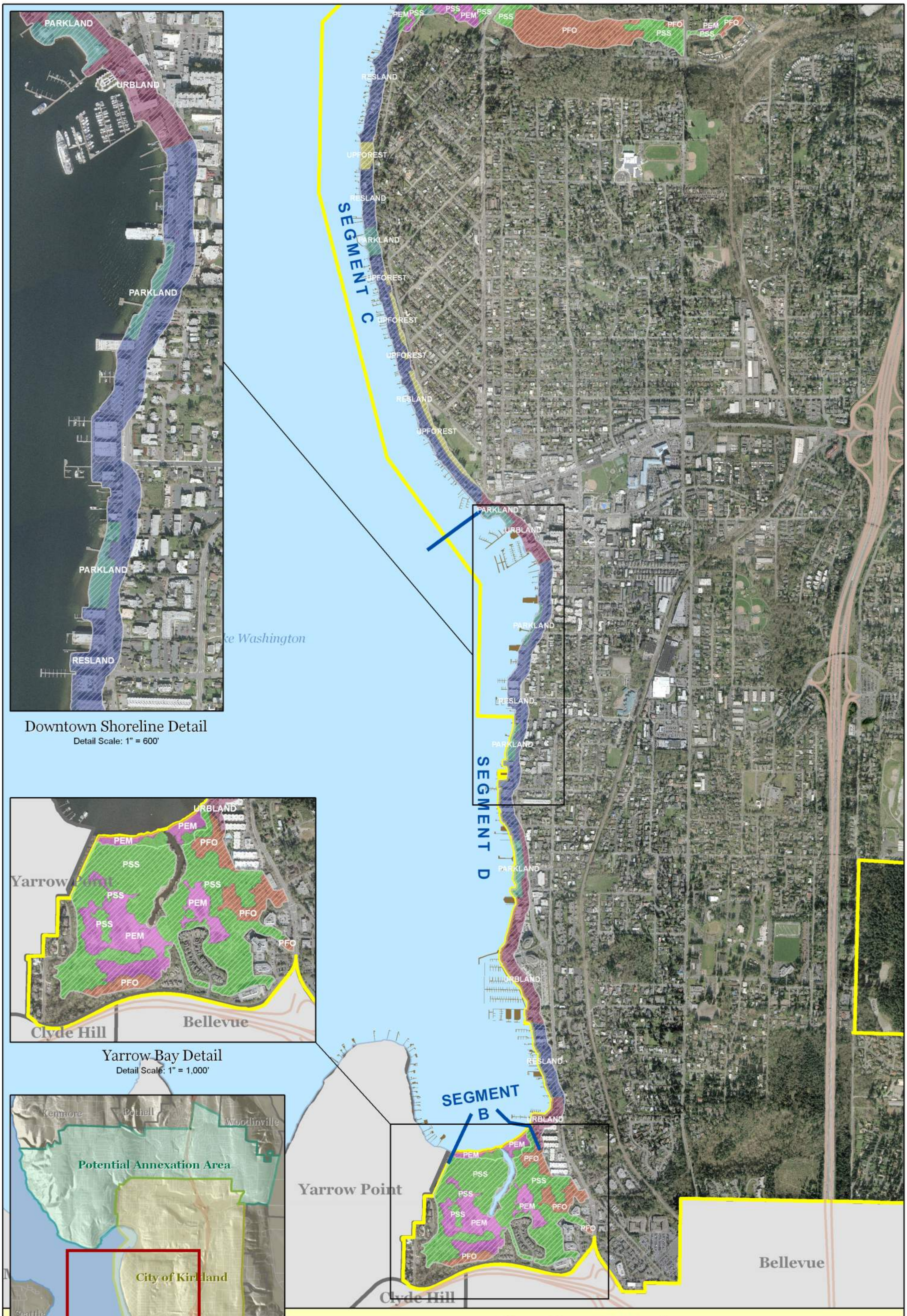
M:\IT\Work\Projects\ShorelineManagement\MXDs\Revision-110606\Fig13-PriorityHabitats.mxd
Figure 13



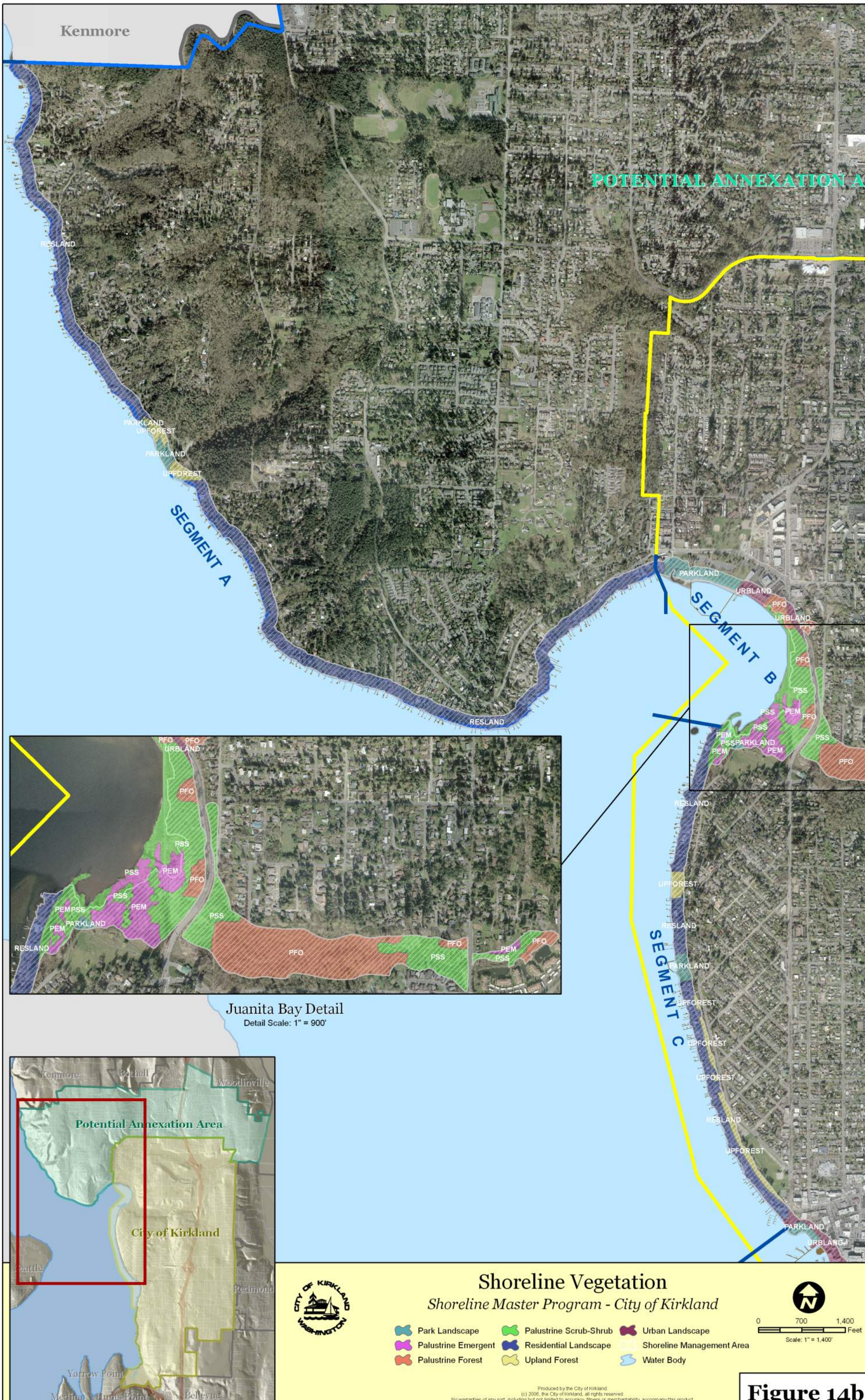
Shoreline Vegetation

Shoreline Master Program - City of Kirkland

Produced by the City of Kirkland.

M:\IT\Work\Projects\ShorelineManagement\MXDs\Revision-110606\Fig14a-Vegetation.mxd

Figure 14a



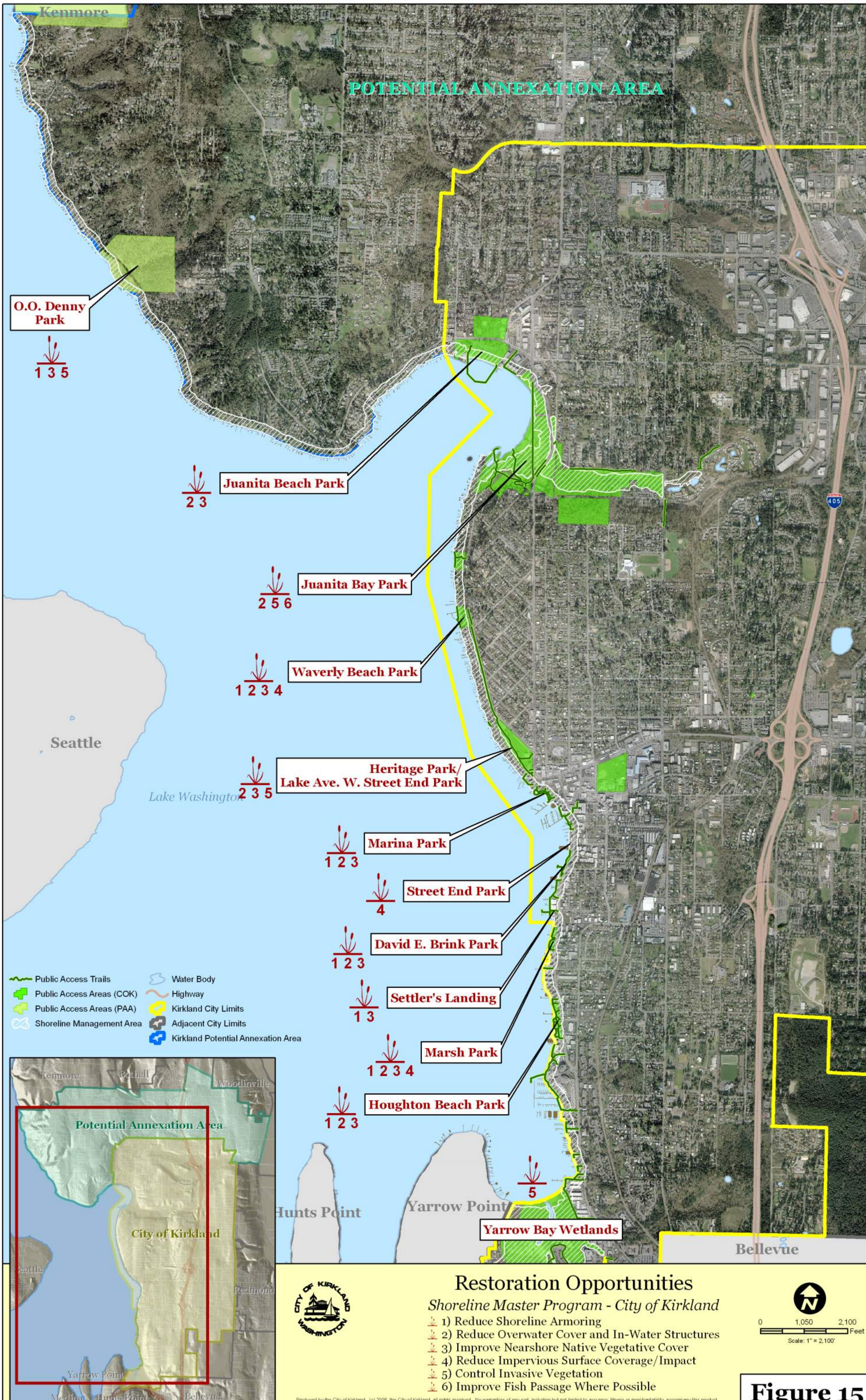
Shoreline Vegetation

Shoreline Master Program - City of Kirkland

Produced by the City of Kirkland

M:\IT\Work\Projects\ShorelineManagement\MXDs\Revision-110606\Fig14b-Vegetation.mxd

Figure 14b

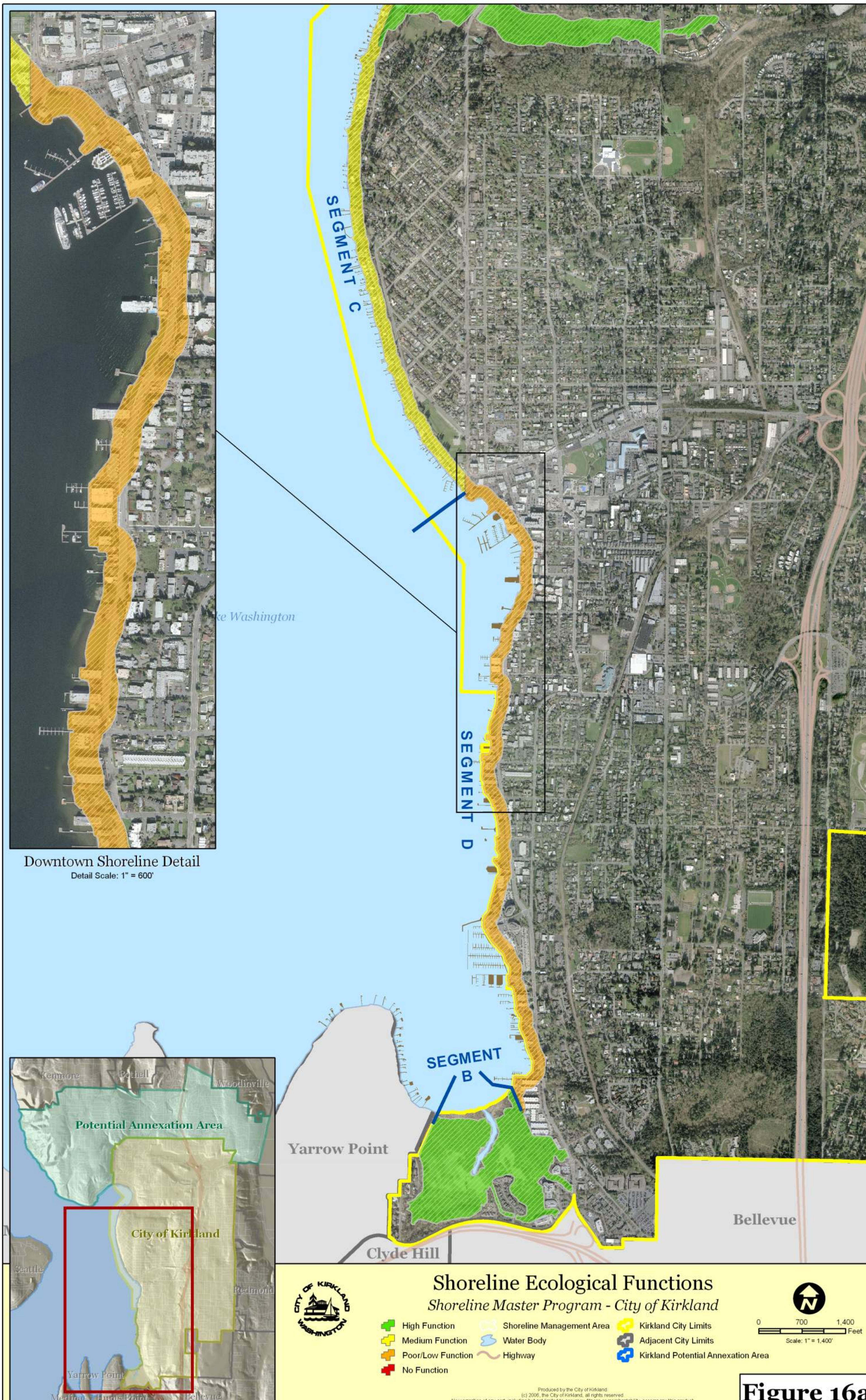


Restoration Opportunities

Shoreline Master Program - City of Kirkland

1) Reduce Shoreline Armoring
2) Reduce Overwater Cover and In-Water Structures
3) Improve Nearshore Native Vegetative Cover
4) Reduce Impervious Surface Coverage/Impact
5) Control Invasive Vegetation
6) Improve Fish Passage Where Possible

Figure 15



SEGMENT C
SEGMENT D
SEGMENT B
Lake Washington
Yarrow Point
Clyde Hill
Bellevue
Downtown Shoreline Detail
Detail Scale: 1" = 600'
Kenmore
Bothell
Woodinville
Potential Annexation Area
City of Kirkland
Seattle
Redmond
Yarrow Point
Medina
Hunts Point
Bellevue
Shoreline Ecological Functions
Shoreline Master Program - City of Kirkland
CITY OF KIRKLAND WASHINGTON
High Function
Medium Function
Poor/Low Function
No Function
Shoreline Management Area
Water Body
Highway
Kirkland City Limits
Adjacent City Limits
Kirkland Potential Annexation Area
N
0
700
1,400
Feet
Scale: 1" = 1,400'
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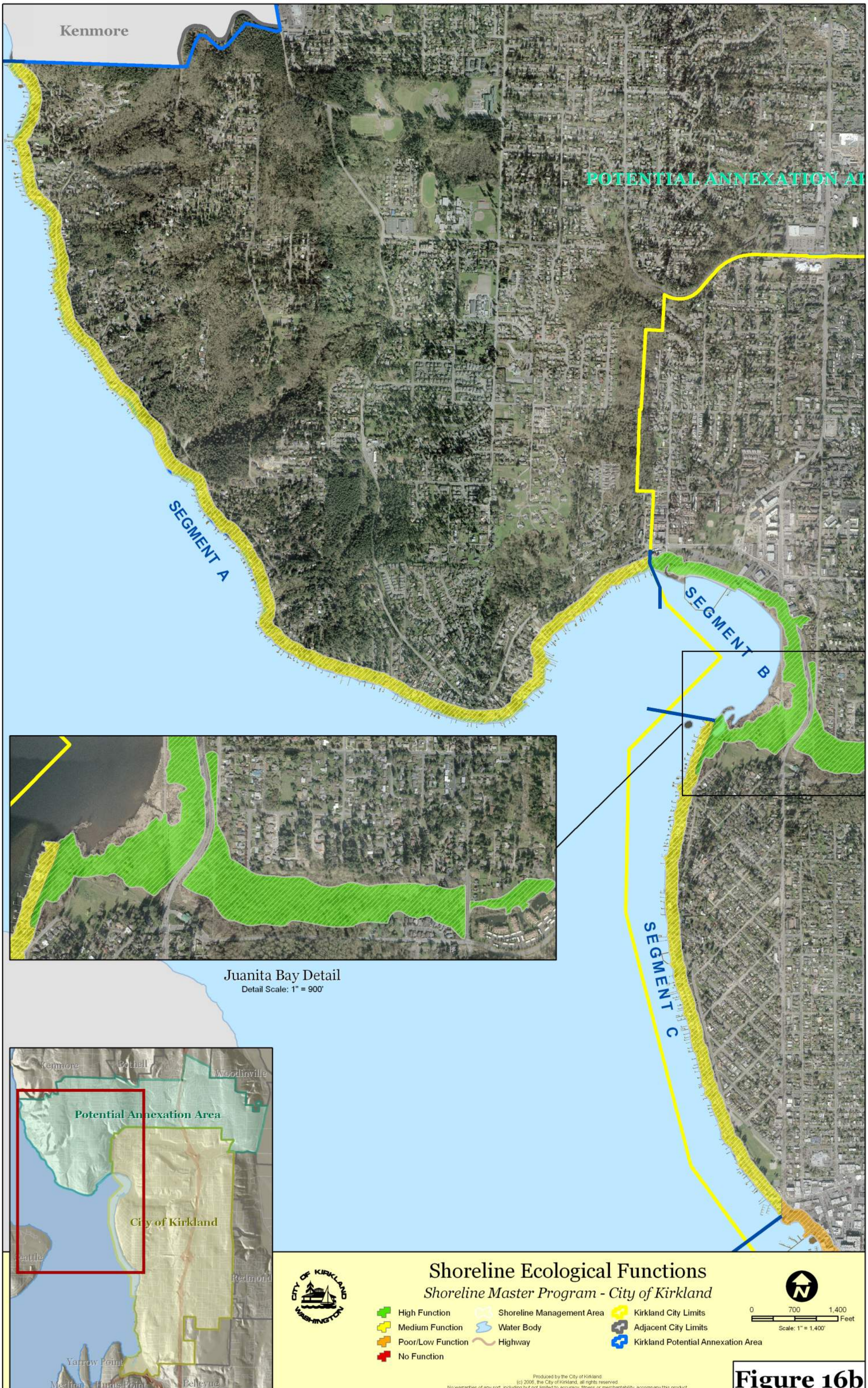
M:\IT\Work\Projects\ShorelineManagement\MXDs\Revision-110606\Fig16a-EcoFunctions.mxd
Figure 16a



Kenmore
POTENTIAL ANNEXATION AI
SEGMENT A
SEGMENT B
SEGMENT C
Juanita Bay Detail
Detail Scale: 1" = 900'
Kenmore
Bothell
Woodinville
Potential Annexation Area
City of Kirkland
Seattle
Redmond
Yarrow Point
Medina
Hunts Point
Bellevue
CITY OF KIRKLAND WASHINGTON
Shoreline Ecological Functions
Shoreline Master Program - City of Kirkland
High Function
Medium Function
Poor/Low Function
No Function
Shoreline Management Area
Water Body
Highway
Kirkland City Limits
Adjacent City Limits
Kirkland Potential Annexation Area
0
700
1,400
Feet
Scale: 1" = 1,400'
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M:\IT\Work\Projects\ShorelineManagement\MXDs\Revision-110606\Fig16b-EcoFunctions.mxd

Figure 16b

APPENDIX F

NONPOINT SOURCE POLLUTION FROM MARINAS AND RECREATIONAL BOATING

Appendix F: Nonpoint Source Pollution from Marinas and Recreational Boating

Marinas, large or small scale, can generate a wide array of pollutants, which can accumulate in the water column, sediments, and aquatic organisms. These include nutrients and pathogens (from pet waste and overboard sewage discharge), sediments (from parking lot runoff and shoreline erosion), fish waste (from dockside fish cleaning), petroleum hydrocarbons (from fuel and oil drippings and spills and from solvents), toxic metals (from antifoulants and hull and boat maintenance debris), and liquid and solid wastes (from engine and hull maintenance and general marina activities; EPA 2001). The effects of these pollutants on waterways and aquatic plants and animals are discussed in this section.

Debris and Litter

The numerous activities that occur at marinas—vessel and engine repair and maintenance, recreation on and off boats, fueling, dock maintenance, and building and grounds maintenance—are sources of a variety of debris and litter. Paper towels and cups, plastic bags, plastic and glass bottles, fish netting, fishing line, discarded oil filters and engine parts, discarded rags, debris from sanding or pressure washing, pet droppings, aluminum cans, and other forms of trash all find their way into surface waters if not disposed of properly (EPA 2001).

Dissolved Oxygen

Sewage discharged from recreational boats, trash tossed into surface waters, pet waste carried to waterbodies in storm water runoff, and fish waste disposed of into surface waters contain organic matter that consumes dissolved oxygen as it decomposes. Consumption of oxygen by decomposing organic matter leaves less oxygen for fish, crabs, clams, and other aquatic organisms. Decreases in dissolved oxygen in several northwestern marinas have been noted in the late summer and early fall, the peak times of marina use (EPA 2001).

Metals

Metals and metal-containing compounds have many functions in boat operation, maintenance, and repair. Arsenic is used in paint pigments, pesticides, and wood preservatives. Zinc anodes are used to deter corrosion of metal hulls and engine parts, and zinc is often a constituent of motor oil and tires. Copper is used as a biocide in antifoulant paints. Chromated copper arsenate (CCA) is used in wood as a preservative. Mercury is contained in many float switches for bilge pumps and shower water storage tank pumps and in air conditioning/heating thermostats. Nickel is a component of brake linings and pavement material, and cadmium is present in batteries and brake linings. These and other metals (aluminum, iron, and chromium) are used in various components at marinas or by recreational boaters and can wash from parking lots, service roads, and launch ramps into surface waters with rainfall (EPA 2001).

Petroleum Hydrocarbons

Sources of hydrocarbons at a marina include fueling stations; operation, maintenance, and repair of boat engines; and storm water runoff from the marina property and off-site upland areas. Petroleum hydrocarbons are contained in fuel, oil, grease, lubricants, finishes, and cleansers. Petroleum can be spilled directly into surface waters when fuel drips from fueling nozzles or a fuel tank is overfilled at a dock. Storm water runoff or seepage can deposit oil, fuel, paint, antifreeze, or other liquids dripped from engines or paint brushes (EPA 2001).

Solvents

Vessel and engine maintenance (painting, cleaning, and repair activities) at marinas utilize solvents that are contained in degreasing agents, varnishes, paint removers, and lacquers. If not properly contained, solvents can potentially enter marina waters through surface water runoff or through ground water transport from hull maintenance areas. Solvents are stable compounds that are insoluble in water, which makes them very mobile in ground water. They are usually heavy, longchain organic compounds, so they sink to an impermeable bottom layer in the ground (like bedrock) and accumulate. Many solvents are known cancer-causing compounds (carcinogens; EPA 2001).

Antifreeze

Antifreeze is used at marinas in dry storage of boats and engine maintenance. It contains either ethylene glycol or propylene glycol. Propylene glycol antifreeze is reported to be much less toxic to aquatic organisms than ethylene glycol and is therefore preferred for use in boats. Both types of antifreeze, however, are considered toxic and should be poured, stored, and drained carefully to avoid spillage. Used antifreeze should be taken to a hazardous waste collection center and recycled if possible (EPA 2001).

Acids

Battery acid is very corrosive and often contains high levels of toxic metals like lead. Cleaning compounds and detergents often contain strong acids or lye. These materials can be washed into the marina basin with the next rain along with the petroleum hydrocarbons, solvents, paint chips, and other material spilled on the ground. Many hazardous waste collection stations accept used batteries (EPA 2001).

Surfactants

Surfactants are compounds used in detergents and other cleaning agents to reduce surface tension. Some are known to be very deadly to aquatic organisms. Surfactants can also accumulate at the water surface and create a barrier against the transfer of dissolved oxygen across the air-water interface, resulting in lowered dissolved oxygen concentrations in the water. For these reasons, surfactants are best not used on boats that are in the water or on upland areas where runoff washes into surface waters (EPA 2001).

References

USEPA. 2001. National Management Measures Guidance to Control Nonpoint Source Pollution from Marinas and Recreational Boating. EPA 841-B-01-005. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

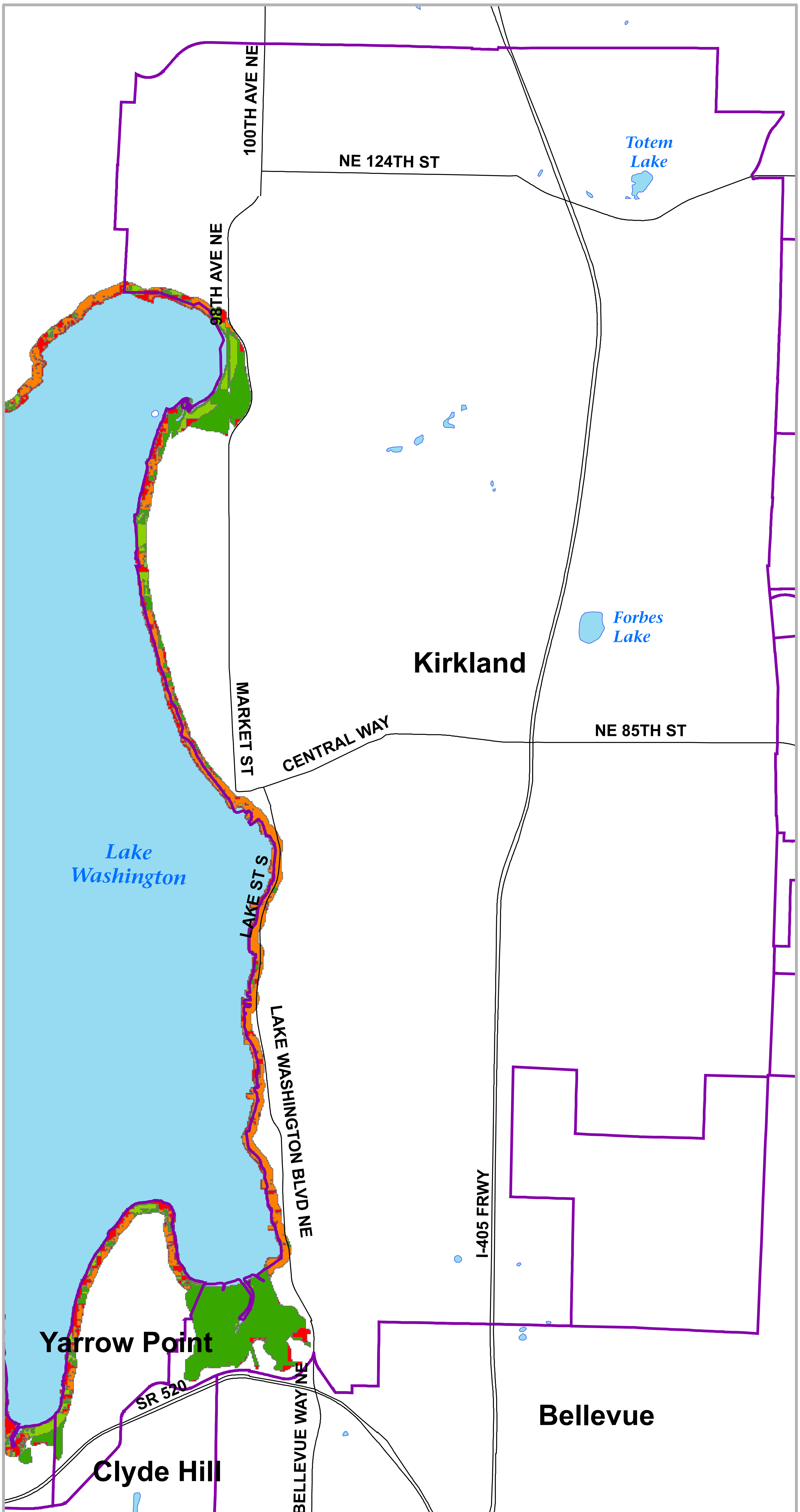
APPENDIX G

KING COUNTY'S SHORELINE CHARACTERIZATION RESULTS FOR KIRKLAND AND THE PAA

Shoreline Characterization Model Results 12/1/06

Kirkland, Washington
King County

DRAFT



Reach Quality

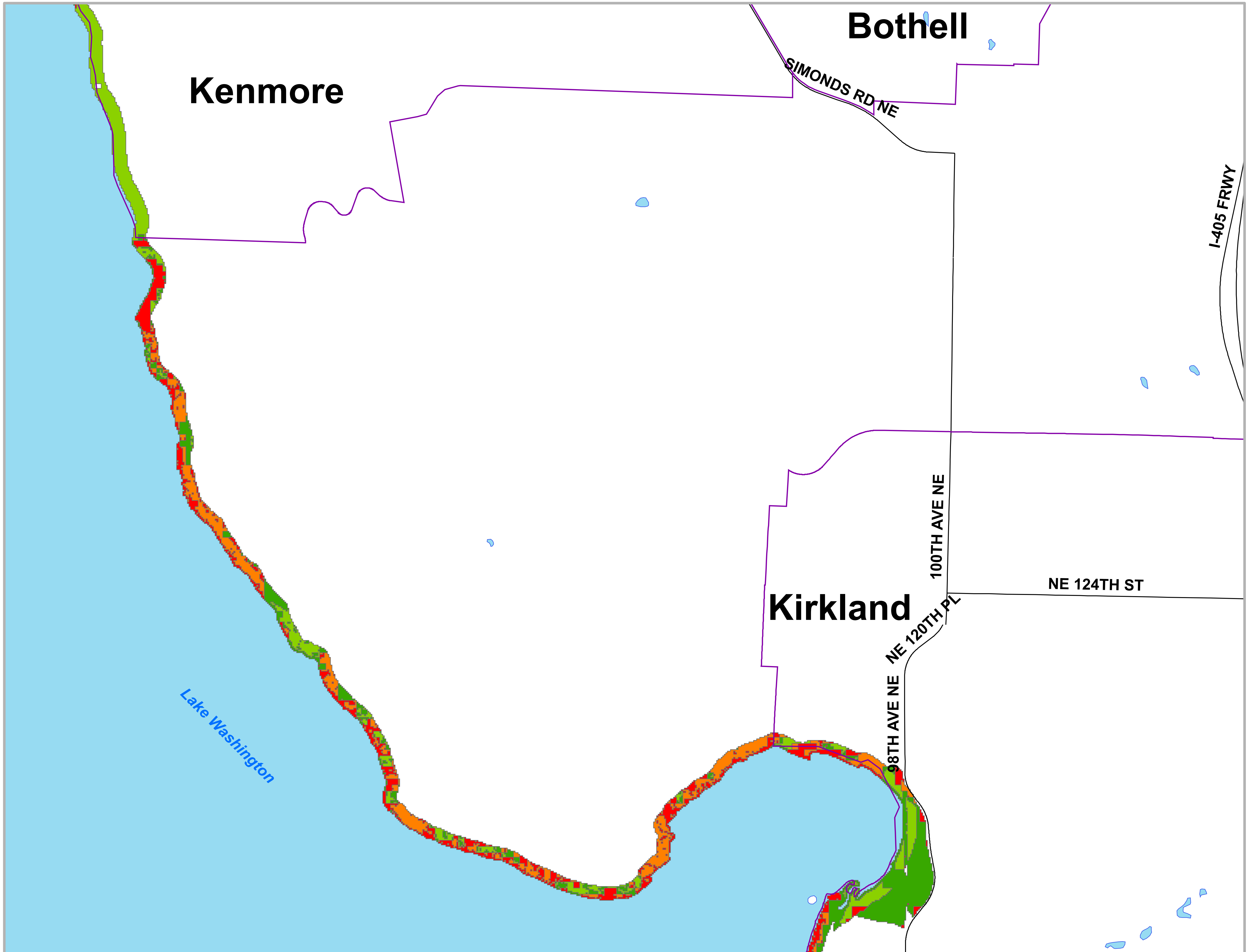
- Low (0-20%)
- Medium/low (20-40%)
- Medium (40-60%)
- Medium/high (60-80%)
- High (80-100%)

- Road
- Incorporated Area Boundary
- Water body

N

0 500 1,000 1,500 2,000
Feet

King County
Department of Natural Resources and Parks
Water and Land Resources Division



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Shoreline Characterization Model Results 12/1/06

Kirkland Potential Annexation Area, Washington, King County

Reach Quality

- Low (0-20%)
- Medium/low (20-40%)
- Medium (40-60%)
- Medium/high (60-80%)
- High (80-100%)
- Road
- Incorporated Area Boundary
- Water body

N

0 1,000 2,000 3,000 4,000 Feet

9/7/06

King County
Department of Natural Resources and Parks
Water and Land Resources Division

APPENDIX H

CITY OF KIRKLAND ORDINANCES & RESOLUTIONS PERTAINING TO THE SHORELINE MASTER PROGRAM

City of Kirkland Ordinances & Resolutions
Pertaining to the Shoreline Master Program (SMP)

DATE	ORDINANCE/ RESOLUTION NO.	SUMMARY OF CONTENT
September 20, 1971	2165	Established a substantial development permit relevant to waterfront and shoreline management (as required by Chapter 286, Laws of 1971, 1st Ex.)—including its definition, application procedure, criteria and implementation process. (NOTE: later Repealed by Ordinance No. 2938)
December 17, 1973	R-2227	Acknowledgement of Lake Washington Regional Shorelines Goals and Policies as prepared by the Lake Washington Regional Citizens Advisory Committee and Technical Committee designated by the Department of Ecology.
December 17, 1973	2244	Amended Section 1 of Ordinance 2160 to require waterfront analysis plans and programs as a component of the Shoreline Master Plan and Comprehensive Plan for the City of Kirkland.
May 20, 1974	2256	Adopted the original Shoreline Master Program (including a shoreline inventory) as the "Waterfront and Shoreline Element of the Kirkland Comprehensive Plan. Repealed Ordinance 2160.
May 1, 1978	2388	Added an additional section (§ 24.04.105) which provides limited administrative review and issuance to certain substantial development activities and permits. (NOTE: later repealed by ordinance no. 2709)
July 10, 1978	2938	Added Chapter 24.05, Shoreline Master Program and Chapter 24.06, Shoreline Administration and Procedures. Repealed Chapters 24.04, 24.05, 24.06. Primarily focused on Planned Area 8 (Totem Lake) and its surrounding wetlands as a natural constraint area. Permitted medium density residential use at 10 to 14 dwelling units per acre under specific conditions pertaining to shoreline regulations.
August 18, 1986	2972	Amended the substantial development permit procedures, administration, and criteria of Section 24.06.040. (2.b) in the Shoreline Master Program. Required permit review to be overseen by the Planning Official.
November 3, 1986	2992	Amended Section 24.06.040 (2.b), Shoreline Administration and Procedures to remove the requirement of designating a Planning Official to oversee substantial development permit review.

DATE	ORDINANCE/ RESOLUTION NO.	SUMMARY OF CONTENT
December 8, 1986	2999	Amended subsection (c) of § 24.06.050, Review of Shoreline Variance to require a city review process for variances under the Shoreline Management Act (using provisions set by Chapter 1550 of Ordinance 1740).
July 5, 1988	R-3463	Adopted revised Shoreline Master Program pursuant to the Shoreline Management Act (RCW Chapter 90.58).
February 7, 1989	3153	Amended Chapters 24.05 and 24.06, Environmental Procedures. Added subsection 3 (Relationship to Other Codes and Ordinances) to Section 24.05.20. Added a new list of definitions, including High Waterline, Inner Harbor Line, Land Surface Modification, Mean Sea Level, Ordinary high Waterline, Outer Harbor Line, Public Access Pier or Boardwalk, Shoreline Conditional Use, Shoreline Master Program, Shoreline Variance and Waterward. Added Public Access Goal and Policies under Section 24.05.65 where the City should seek to complete a public pedestrian walkway along the shoreline from Juanita Bay Park. Added Use Regulations pertaining to Conservancy 1 and 2 Shoreline Environments.
May 2, 1995	3463	Amended Shoreline Environments Map for the Kirkland Shoreline Master Program to an area within (and adjacent to) Juanita Bay of Lake Washington.
May 18, 2004	3945	Amended the Kirkland Shoreline Master Program (Chapter 24.05, Title 24 of the Kirkland Municipal Code) to incorporate Urban Mixed Use 1 Shoreline Environments exceptions pertaining to lot sizes and use regulations.
July 6, 2004	3950	Amended Kirkland Shoreline Program (File No. ZON04-00004) to address severability and repeal Ordinance 3945.